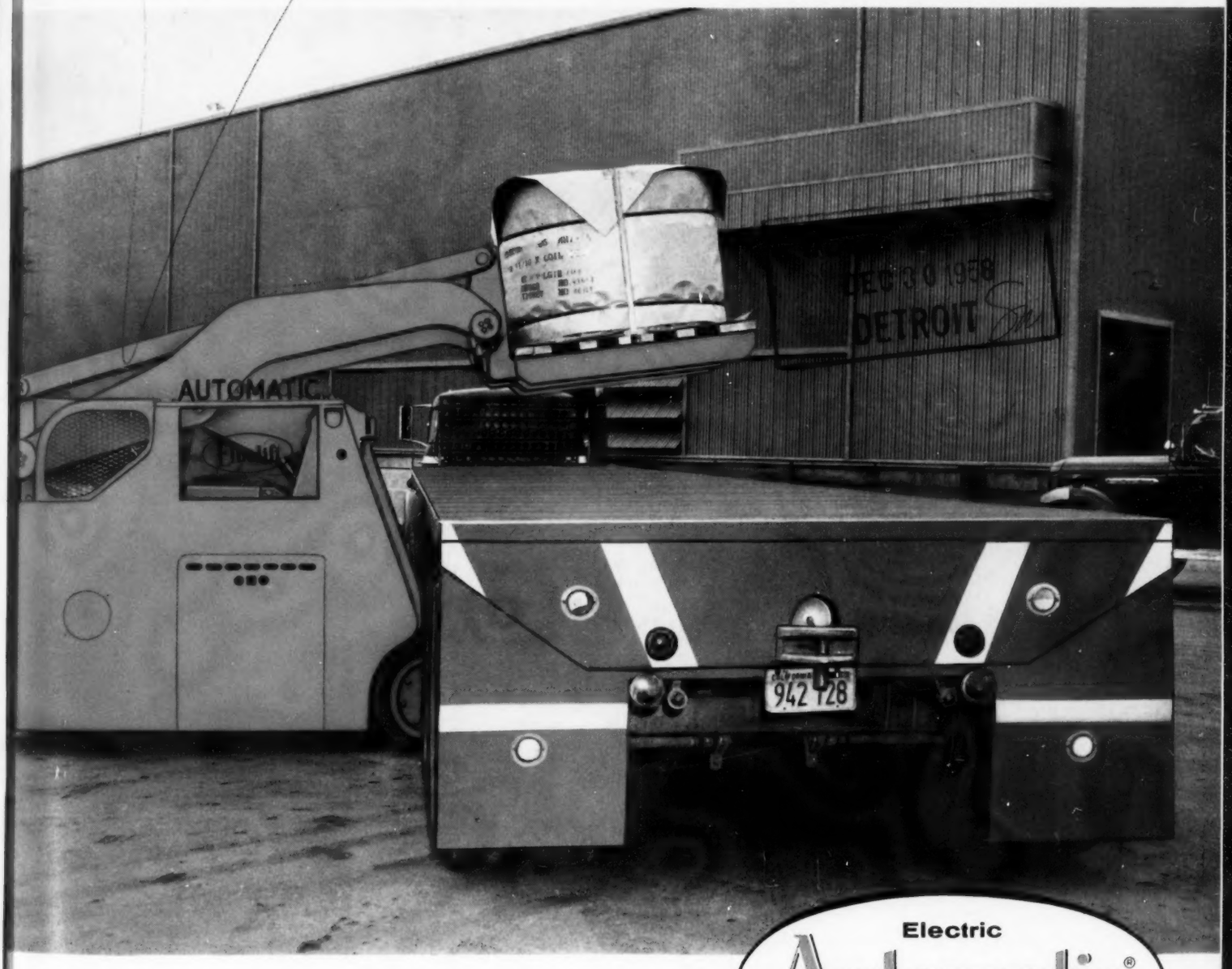
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

DECEMBER, 1958 TECHNOLOGY DEPT. TABLE OF CONTENTS, PAGE 3

Kaiser Steel Corporation's AUTOMATIC Elbolift is a Versatile Coil Handler



The Automatic Elbolift at Kaiser Steel Corporation's Fontana plant really gets a workout. Among other jobs, it moves coils of tinplate weighing up to 20,000 pounds from the upending and palletizing center into storage and stacks them 3-high. Next move is to the shipping area where Elbolift spots each coil in the center of an over-the-road flat bed truck...all in one operation—it takes much less time and maneuvering than conventional mast-type lift trucks. The Elbolift can also load and unload DF boxcars...8 coils to a car! Capacities range from 12,000 to 25,000 pounds. Write for illustrated folder.

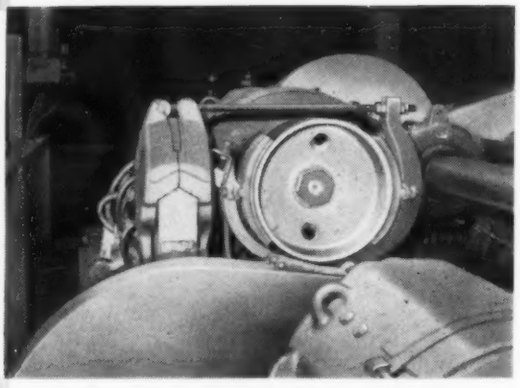
Electric Automatic® Industrial Trucks

Cost less to own... less to operate

AUTOMATIC TRANSPORTATION COMPANY
Division of The Yale & Towne Manufacturing Company
Dept. X-8, 47 West 87th Street, Chicago 20, Illinois
WORLD'S LARGEST EXCLUSIVE BUILDER OF ELECTRIC-DRIVEN INDUSTRIAL TRUCKS

Cutler-Hammer 505 Mill Brakes set new performance records at Inland Steel

Cold Strip Finishing
Mill Crane 35B



This 16" Cutler-Hammer 505 Mill Brake was installed in 1954, first to be used by Inland Steel. Service records show nine months passed before the brake required an adjustment of the shoe clearance. To date the original linings and wheel are still in service.

PROOF OF DEPENDABILITY

Here's positive *proof of dependability* . . . proof that Cutler-Hammer 505 Mill Brakes work better and last far longer even under the most severe operating conditions. Why take chances with costly production interruptions caused by frequent mill brake service requirements? Install dependable, service-proven Cutler-Hammer 505 Mill Brakes and be sure. For complete information, write today for Bulletin 505-Y-232. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

CUTLER·HAMMER

CUTLER-HAMMER CONTROL C-H

Cutler-Hammer Inc., Milwaukee, Wis. *Division:* **Airborne Instruments Laboratory.** *Foreign:* **Cutler-Hammer International, C. A.**
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation, Inc.

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers at 20th and Northampton Sts., Easton, Pa. Editorial and advertising offices, 1010 Empire Bldg., Pittsburgh 22, Pa. Second-class mail privileges authorized at Easton, Pa.

To Pa Pitt, we are youngsters, but in the Steel Industry we are one of the older members of the family. For 56 years, we have been making Pipe & Tube Mills, Sheet and Strip Equipment, Continuous Processing Lines, Drawbenches, Rolls, and Other Products for Steel . . . as well as the Copper, Brass, Aluminum, Rubber, and Chemical Industries. We salute Pa Pitt's 200th Birthday and plan to be around for another salute on his next Centennial.

Pittsburgh Bicentennial
1758- 1958- 59

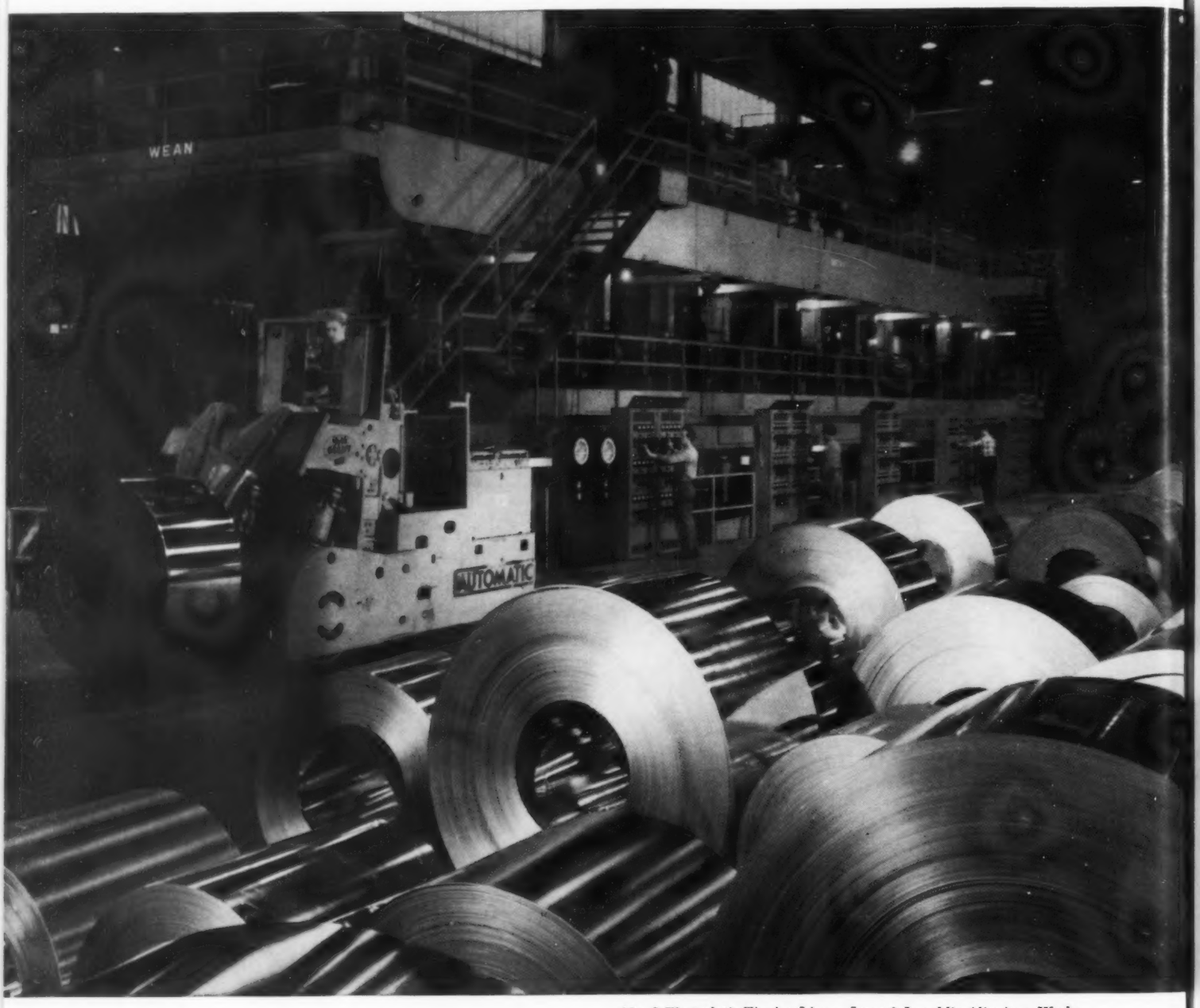
the
Aetna-Standard
engineering
company

General Offices:
Pittsburgh, Pa.

Plants:
Ellwood City, Pa.
Warren, Ohio

Research Laboratory:
Akron, Ohio

9,324 #2 Cans of Corn Per Minute...



No. 3 Electrolytic Tinning Line — Jones & Laughlin Aliquippa Works

This is the way the food industry might rate the speed of this Wean Electrolytic Tinning Line. And canners across the country recognize that such a modern, continuous, high speed tinplate line makes an important contribution to their business. For quality tinplate, produced at speeds up to 2000 fpm, is the low cost material from which over three billion "tin cans" are made annually.

Forty-seven Electrolytic Tinning Lines, engineered and constructed by Wean, account for more than 75% of the annual tinplate production.

THE WEAN ENGINEERING COMPANY INC. • WARREN • OHIO

2309

T. J. ESS, *Editor*
I. E. MADSEN, *Associate Editor*
W. C. FRIESEL, *Advertising Manager*
T. A. KOCIS, *Production Manager*

Board of Directors

PRESIDENT
LEONARD LARSON
Chief Engineer
Cleveland Works, Republic Steel Corp.

FIRST VICE PRESIDENT, EMIL KERN, *Vice President of Engineering*, Allegheny Ludlum Steel Corp.

SECOND VICE PRESIDENT, S. C. READ, *Director, Construction and Maintenance*, Jones & Laughlin Steel Corp.

TREASURER, C. E. PRITCHARD, *General Superintendent of Mills*, Alan Wood Steel Co.

SECRETARY, H. L. JENTER, *Vice President—Operations*, American Steel and Wire Div., United States Steel Corp.

PAST PRESIDENTS: W. H. COLLISON, *Plant Superintendent*, Blast Furnaces and Coke Plant, Great Lakes Steel Corp.

J. D. O'ROARK, *Assistant Manager*, Department of Service and Maintenance, Electric, Weirton Steel Co.

DIRECTOR-AT-LARGE, C. W. BRUCE, *Chief Engineer*, Steel Plants, Republic Steel Corp.

DIRECTORS: F. B. BEVELHEIMER, *Power & Fuel Engineer*, Jones & Laughlin Steel Corp.

E. C. THOMAS, *Vice President—Operations*, Pacific States Steel Corp.

J. R. POWELL, *Cleveland Works Manager*, Jones & Laughlin Steel Corp.

A. M. CAMERON, *Superintendent*, Blooming & Bar Mills, Atlas Steels, Limited.

C. A. BAILEY, *Lubrication Engineer*, National Tube Div., United States Steel Corp.

H. R. KNUST, *Assistant General Manager*, Sparrows Point, Bethlehem Steel Co.

A. KRAUSE, *Manager*, Rolling Mill Plant, Steel Div., Ford Motor Co.

W. T. PURVANCE, *Project Analysis Engineer*, United States Steel Corp.

W. D. REES, *Superintendent*, Bar & Blooming Mill, Sharon Steel Corp.

J. E. BODOH, *General Supervisor—Electrical*, Gary Steel Works, United States Steel Corp.

S. O. EVANS, *Manager of Tubing Operations*, The Babcock & Wilcox Co.

F. H. WICKLINE, *Assistant Chief Engineer*, National Tube Div., United States Steel Corp.

GEORGE H. SCHAEFFER, JR., *Superintendent of Electrical Dept.*, The Carpenter Steel Co.

R. J. TREMBLAY, *General Manager*, Los Angeles Bethlehem Pacific Coast Steel Corp.

A. S. MERROW, JR., *Assistant Fuel Engineer*, Bethlehem Steel Co.

A. W. SCHLECHTE, *Chief Electrical Engineer*, Granite City Steel Co.

H. B. BUCKINGHAM, *Electrical Engineer*, Tennessee Coal and Iron Div., United States Steel Corp.

Managing Director
T. J. ESS
Empire Building, Pittsburgh, Pa.

Iron AND Steel ENGINEER

Volume XXXV · Number XII **DECEMBER 1958**

61 Standardization of Steel Mill Crane Control Systems
by K. S. Kuka

73 Coke and By-Products in 1957
by I. E. Madsen

79 Measuring the Investment Worth of Capital Expenditure Proposals
by A. D. Howry

87 Current AISE District Section Meeting Notices

88 Open Hearth Fuel Atomization with a Reaction-Type Jet Burner
by A. L. Hodge and G. W. Hinds

96 Available Translations

97 Hydraulic Jet Descaling—A New Method to Remove Scale from Hot Steel
by Benj. G. Harmon and Robert V. Proctor

109 Development of Atomic Power and Its Possible Applications to the Steel Industry
by Howard D. Philipp

117 Recent Lubrication Experiences in the Sparrows Point Plant
by Thomas A. Bessent

124 500-Ton Hot Metal Ladle Crane
by Charles F. Simmers

132 Crane and Mill Auxiliary Drive Motor Cable Size Wiring Standards—AISE Standard No. 8

138 Pipe Mill Solves Variety of Heating Problems

143 Selecting Fire Resistant Hydraulic Fluids

145 New Variable Speed Drive Line Features Reduced Space Requirements

148 Automatic Gage Control Is Applied on New High Speed Tandem Tinplate Mill
by Alonzo F. Kenyon

208 AISE Yearly Index

DEPARTMENTS

11 Crops and Shorts
25 Patent Reviews
155 Date-line Diary
159 Publication Service
163 Industry News
179 Personnel News
195 Equipment News
201 Book Reviews
215 Index to Advertisers

Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

Copyright, 1958, The Association of Iron and Steel Engineers.

Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds)..... $ 7.50 per year
Subscription price in foreign countries (U. S. funds) ..... $10.00 per year

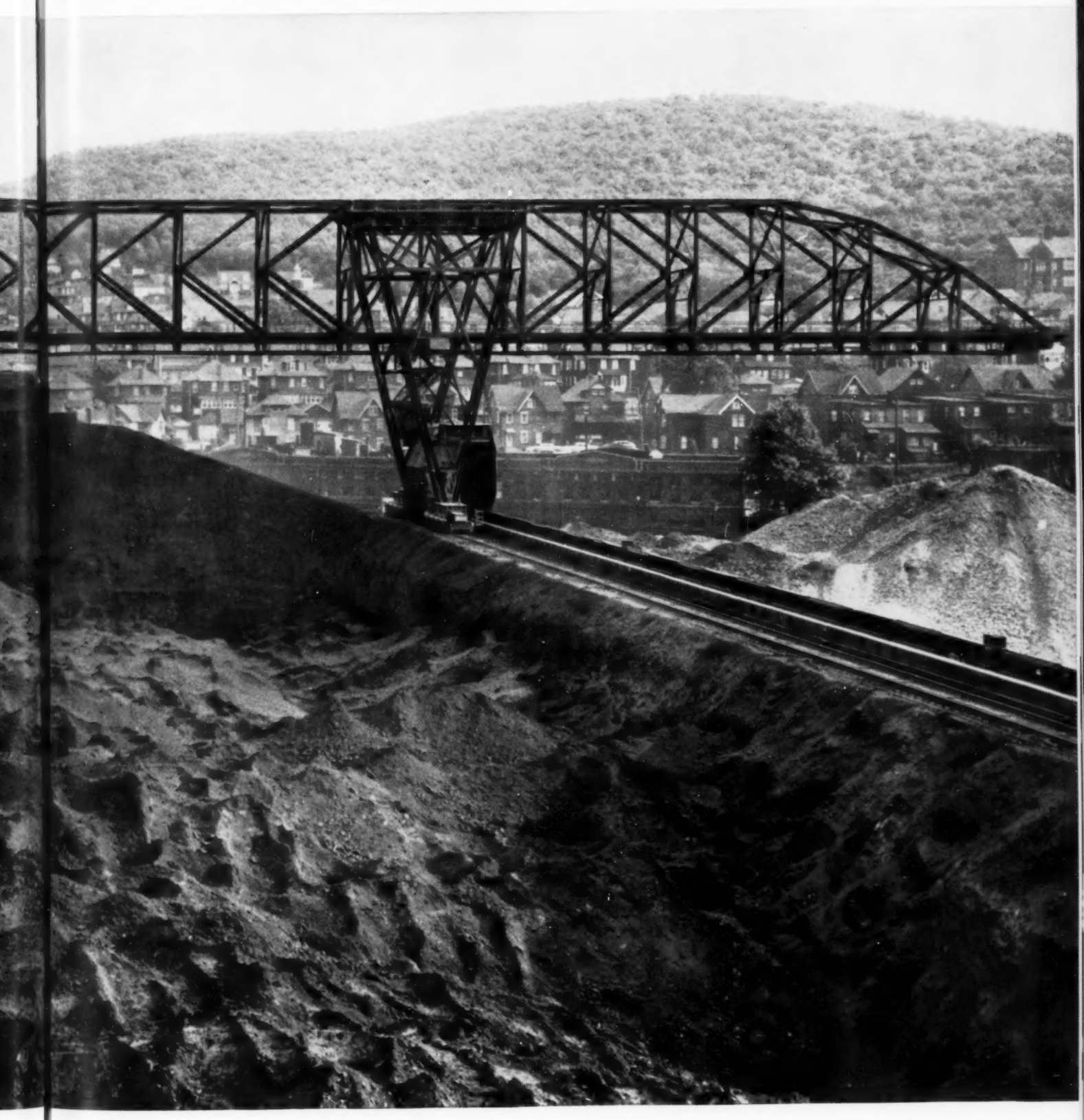
BETTER EQUIPMENT MEANS B

Economy, Safety, Dependability

. . . are built into Dravo

Bridges—Unloaders—Towers

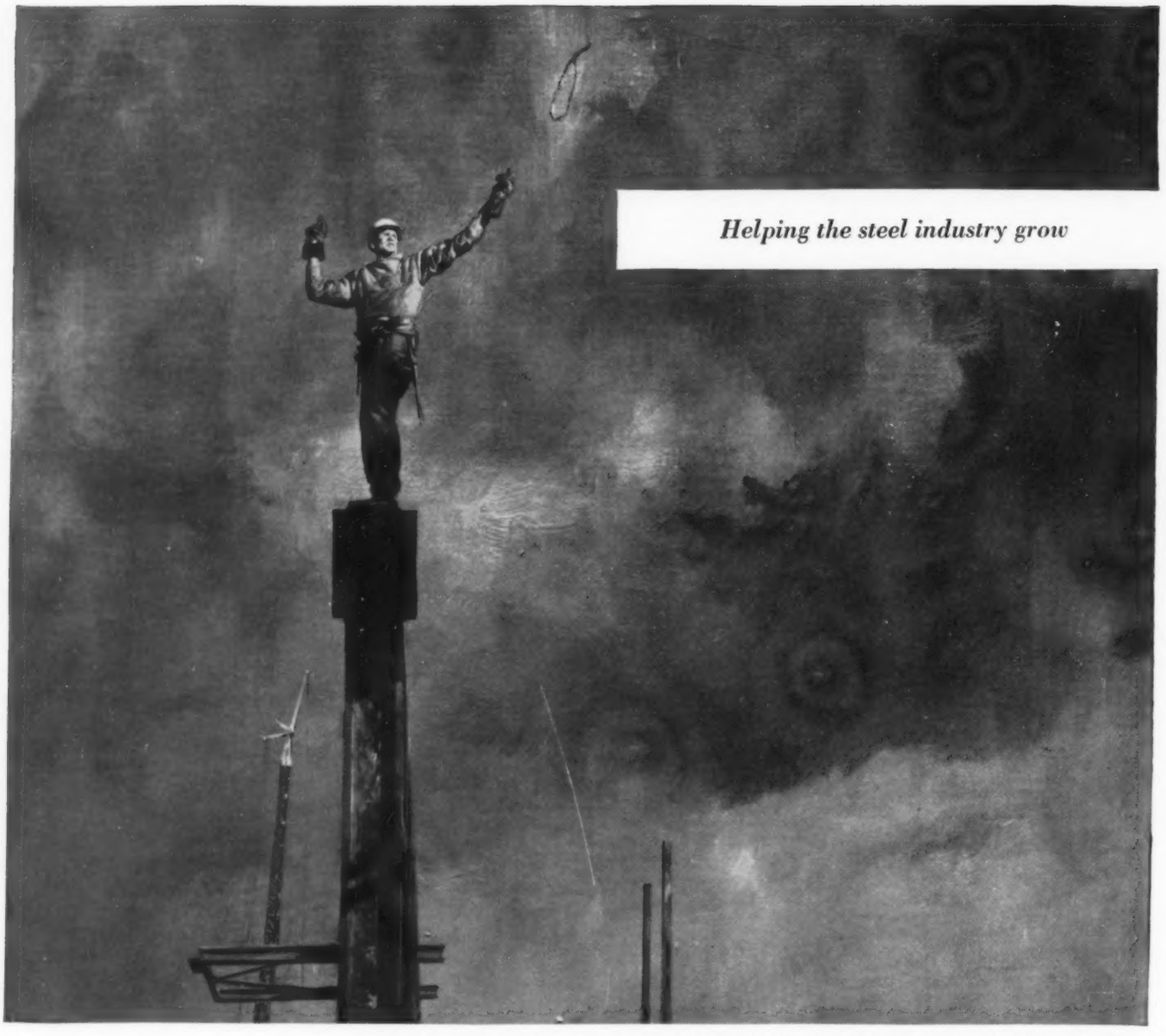
BETTER PERFORMANCE



DRAVO

CORPORATION

PITTSBURGH 25, PA.



Steel soars skyward as girders are spudded and bolted into place by catfooted high-steel workers. Crack engineering teams, men whose life is construction, an endless river of steel—together they answer the call of our growing industrial economy. Composed by Stanley Meltzoff.

Control Costs in Construction

Regardless of the size and complexity of a project, cost control is invariably an important factor in its design and construction. Our experienced teams have proved over and over their ability to complete projects on schedule and within established budget limits. We offer a broad, flexible range of services—and facilities for moderate or extensive needs.

We have served many of the country's leading steel producers, designing and installing such facilities as rolling mills, slab heating furnaces, sintering strands, desulfurizer stations, oxygen plants, power plants, and coal handling equipment.

Let the skills and creative abilities of United Engineers augment the engineering staff of your own organization. We invite you to share and profit from our background of more than 70 years' experience.

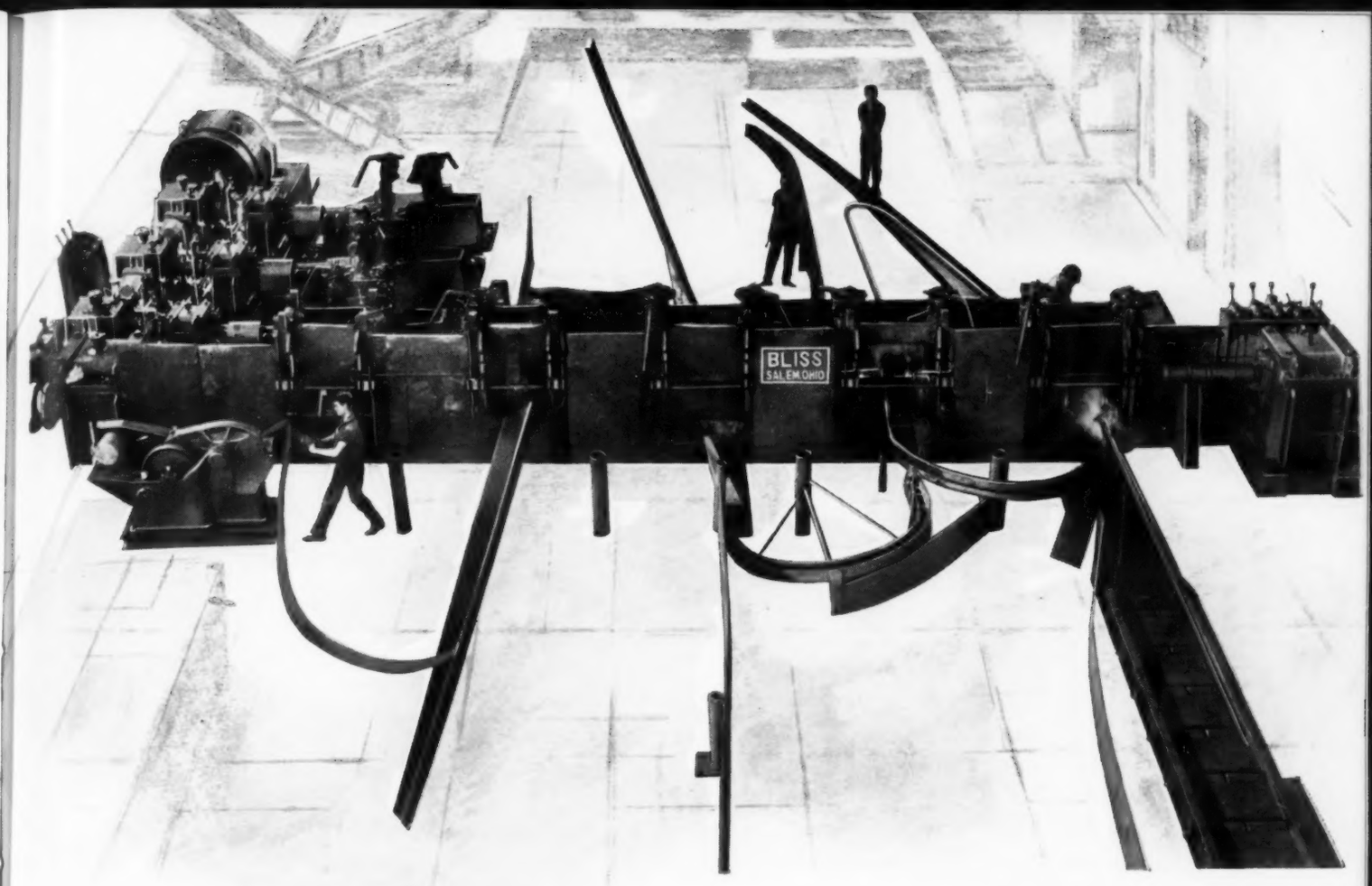
UNITED ENGINEERS

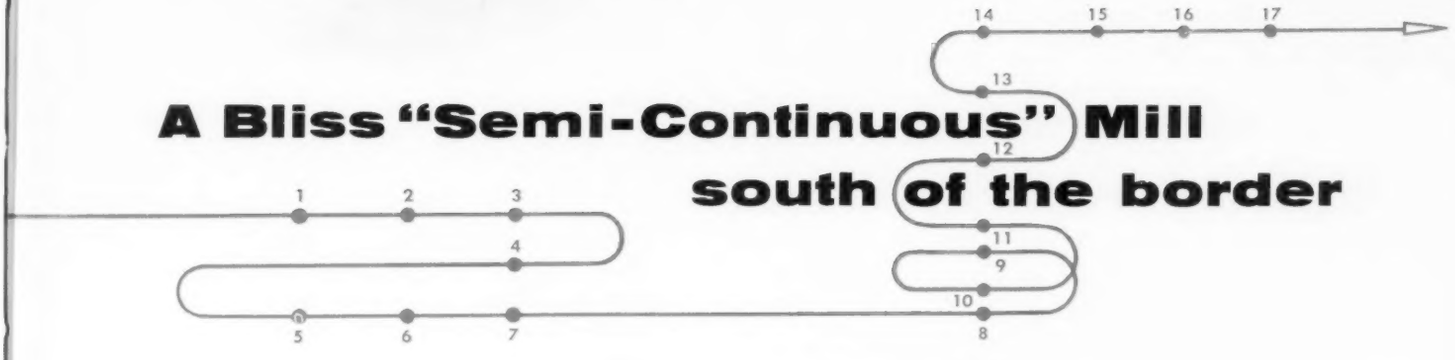
& Constructors Inc

U.E.&C. (Canada) Ltd.

Designers • Constructors • Consulting Engineers

New York • PHILADELPHIA • Chicago





A Bliss "Semi-Continuous" Mill south of the border

Mexican cotton growers no longer need to import their baling strip, thanks to this new Bliss 11-stand Semi-Continuous mill recently put into operation by Aceros de Chihuahua, S. A.

Although the mill was primarily designed for production of narrow hot strip for cotton baling, Bliss and Aceros engineers designed it with an eye towards other uses too: as a result, the mill is suitable for production of rod and small shapes. Above all, it is simple to operate and easy to maintain.

Most of Aceros' requirements were handled by Bliss: the equipment moving billets in and out of the furnace, mill entry, the three stand tandem roughing mills, 12 x 30" and two 12 x 24" intermediate stands, a three-stand finishing train, and most of the auxiliary equipment, including repeaters, terminal equipment and scrap baller.

In essence, the mill represents the wedding of the best of American and Mexican steelmaking "know-how". In this as in so many other installations, Bliss "tailored" its mill to the particular needs of the operator. For other examples of Bliss mills around the free world, write for our new 84-page Rolling Mill brochure, Catalog 40-B.

BLISS
SINCE 1857

Bliss is more than a name . . . it's a guarantee

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

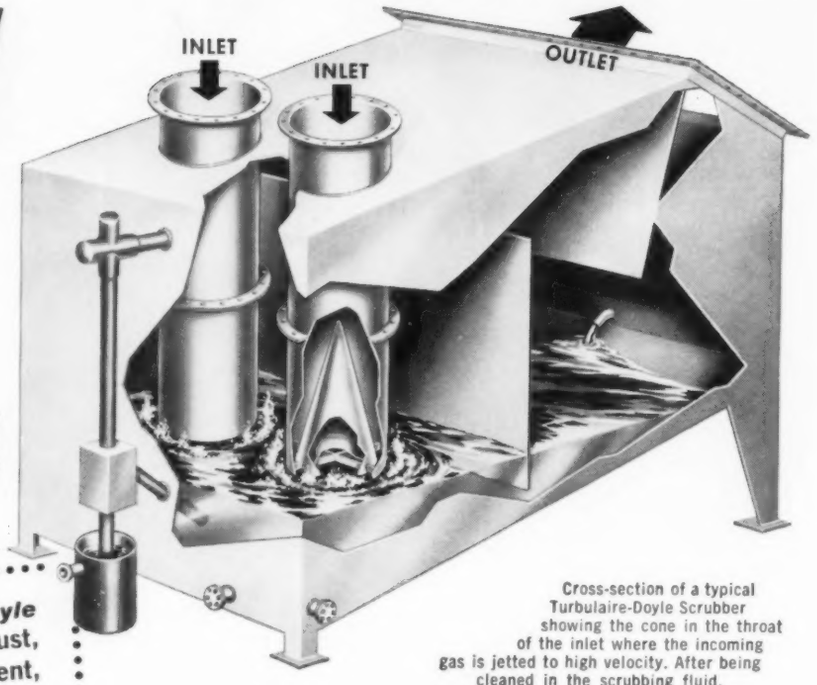
Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio

NEW

Savings and efficiencies in Gas Scrubber Applications

with the

TURBULAIRE-DOYLE SCRUBBER



Cross-section of a typical Turbulaire-Doyle Scrubber showing the cone in the throat of the inlet where the incoming gas is jetted to high velocity. After being cleaned in the scrubbing fluid, the gas passes over spray eliminator baffles before it is discharged. Collected material is carried away by the circulating scrubbing liquid—Is recovered as a liquid concentrate or slurry.

With addition of the Turbulaire-Doyle Scrubber to its line of advanced dust, fume and fly ash collection equipment, there is no industrial gas cleaning problem that Western Precipitation cannot handle with equipment of its own design. This assures your dust and fume control problem receiving the benefit of the industry's most complete "know-how" in all phases of gas cleaning operations.

The Turbulaire-Doyle Scrubber—a development of The Consolidated Mining and Smelting Company of Canada Limited and widely used in its own diversified operations—is now made available to industry by Western Precipitation Corporation under a license arrangement with Cominco.

Actual plant records, compiled over long periods of service, show the Turbulaire-Doyle Scrubber to be unique among commercially-available scrubbers in the multiple advantages it offers...

★ *High Collection Efficiencies*—generally 97% to 99%!

★ *Fine Particle Collection*—including those in the fume range!

★ *Low Liquid-to-Gas Ratio*—only 1 to 5 GPM per 1000 CFM!

★ *Wide Application Flexibility*—readily adaptable to various types of corrosion-resistant materials!

SIMPLE, TROUBLE-FREE DESIGN

The Turbulaire-Doyle Scrubber impinges dust-laden gas at high velocity into a bath of scrubbing liquid. The high velocity forces the gas and dust particles to penetrate deeply into the liquid for complete wetting and cleansing. A cone in the gas inlet nozzle, just above the surface of the scrubbing bath, provides the jetting action that assures outstanding performance from this unit. *There are no moving parts, nothing to require frequent maintenance!*

If you have dust or fume control problems where scrubber types of collectors are applicable, it will pay you to investigate the *years-ahead* advantages of the Turbulaire-Doyle Scrubber. Write, wire or phone the Western Precipitation office nearest you for further details.

TYPICAL APPLICATIONS INCLUDE:

Cleaning Gases from sintering machines, blast furnaces, roasters, dryers, calciners, crushers, screens, ventilators etc., in a wide range of chemical, metallurgical, rock products, and waste disposal operations.

Cooling and Humidifying Gases from fertilizer, acid, carbonating, smelting, alloying, and reclaiming operations where cool, moist gases are necessary for proper processing.

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
TURBULAIRE-DOYLE Scrubbers
HOLO-FLITE Processors
HI-TURBIANT Heaters

WESTERN
PRECIPITATION
CORPORATION

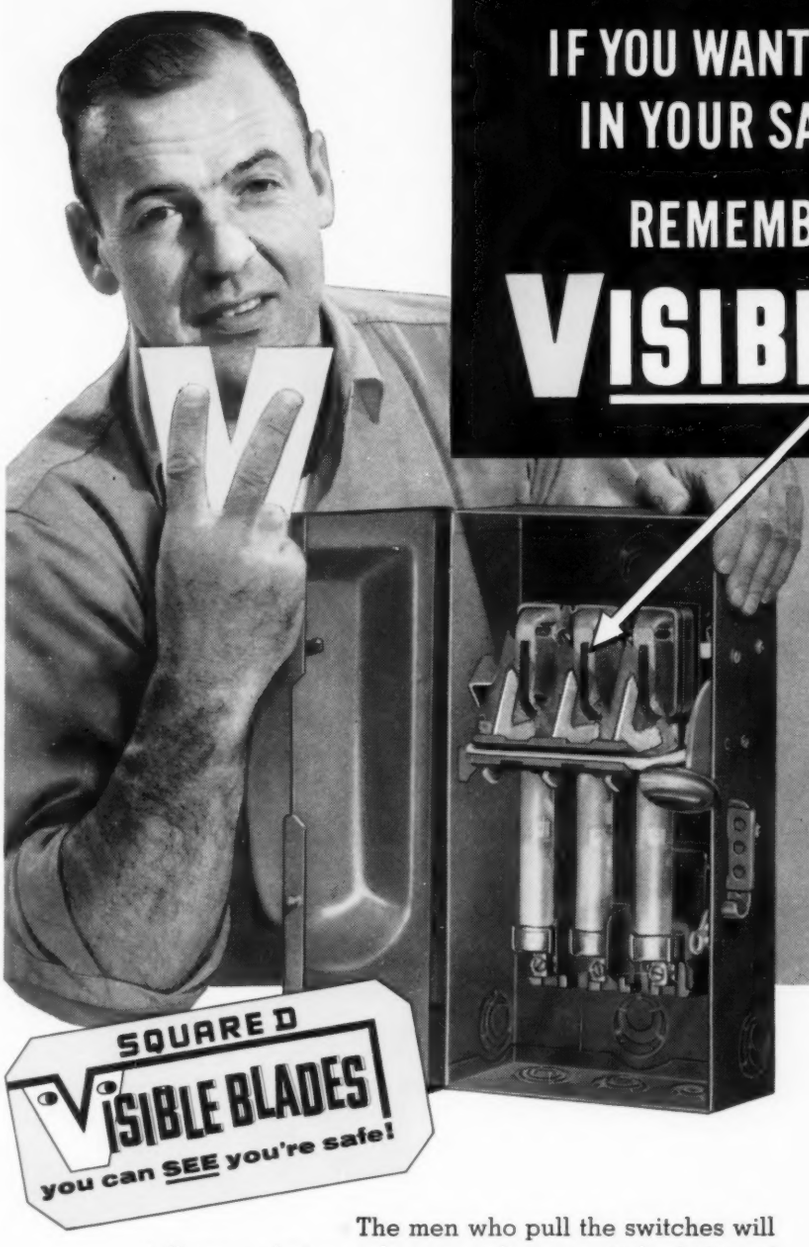
Engineers and Constructors of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

LOS ANGELES 54 • NEW YORK 17 • CHICAGO 2 • PITTSBURGH 22 • ATLANTA 5 • SAN FRANCISCO 4

Representatives in all principal cities

Precipitation Company of Canada Ltd., 8285 Mountain Sights Avenue, Montreal 9

IF YOU WANT COMPLETE SAFETY IN YOUR SAFETY SWITCHES— REMEMBER THE "V" FOR VISIBLE BLADES!



The men who pull the switches will tell you what can happen when a switch, *believed* to be open—*isn't.* A lot of things can happen—and every one of them is bad. Personnel safety is in jeopardy. Motors can single-phase. Machinery and work can be damaged. Down-time can skyrocket.

Doesn't it make sense to insist on Visible Blade construction which gives you a road block against any of those possibilities? Doesn't it make equally good sense to insist on the safety switch which gives you that construction—plus a lot of other performance advantages?

HERE IS ANOTHER REASON WHY SQUARE D HAS HELD FIRST PLACE FOR MORE THAN 50 YEARS

Positive Pressure (SPRING LOADED) Fuse Clips

✓ Maintain positive contact as fuses alternately heat and cool. Fuses are held tight even where vibration is present or during short circuit surges.

✓ Fuse clip jaws use pure copper for current-carrying parts and spring steel for pressure. They reduce heating 80% over commercial type clip.

✓ No clamps or screws to tighten—or to forget to tighten.

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

CLEVELAND CRANES MODERN ALL-WELDED STEEL MILL CRANES

THE CLEVELAND CRANE & ENGINEERING CO.
5031 EAST 289th STREET • WICKLIFFE, OHIO

Crops *and* Shorts

△ A few months ago on this page we talked about the universal credit card craze and raised the objection that businesses would have to raise prices to take care of the six or seven per cent commisson that the credit agencies will charge.

We'd like to tip our hat to the restaurant industry of the West Coast, particularly Seattle, where a five per cent service charge will be added to credit card charges after January 1.

Needless to say, the credit organizations are criticizing the plan, but it seems to make a lot of sense. Why should prices on cash business be raised to pay the discount on credit business?

Universal credit cards were originally brought out as a convenience for travelers, but the intense promotion by the various agencies issuing such cards is putting a card in every wallet, and restaurants and hotels, at least, can't afford it.

△ According to the American Iron and Steel Institute, the making of iron and steel products and their direct use or further fabrication account for 37 per cent of all manufacturing jobs in the United States. For each production worker at blast furnaces and steel mills, more than nine others work in manufacturing establishments which utilize iron and steel products. Not included in this figure are many workers in nonmanufacturing industries (mining, transportations, construction, etc.) who nevertheless depend on the iron and steel industry for all or part of their livelihood.

△ The Wall Street Journal says:" Speaking of trade relations, almost every one would like to."

△ Too much of our money is being taxed away and borrowed to support a level of spending which cannot be justified if we are to maintain satisfactory economic growth under a free system. Much of this leads to inflation. Our bond market, which is an essential item in the operation of an enterprise economy, is suffering from the public's inflation-mindedness. Some of this would be cured if federal spending was reduced. This will occur only if we—all of us—are able to convince our elected representatives—federal, state and local—that we want them to economize—and we'll have to be darned persuasive.

△ It could come only from a pessimist:

When life is rough and skies are gray
My comment is a terse one:
Tomorrow is another day—
Quite probably a worse one.

△ A report from the 1958 Paris Auto Show: "The new American cars, to the increasing puzzlement of Europeans and Americans still from Missouri, were generally even larger, wider, finnier, more powerful and gas-hungry than ever before. To the expert observers and potential consumers come to see the trends and maybe place an order, they seemed more like space cruisers than modern means of land transport. Most Eureopans, at least, will never understand the need for all the power, space and frills.

"By comparison, most European cars seemed more compact, less chrome-prone, sometimes more comfortable, and on the whole more common sense."

△ C. M. White, chairman of the board of Republic Steel Corporation, sees the major problem facing the steel industry to be how to raise the $20,000,000,000 needed to pay for the increased steel capacity needed over the next two decades.

△ There are now more than 68,000,000 motor vehicles in the United States—and isn't it amazing how there's always parking space in front of the bank, post-office or what-have-you—in television and the movies?

△ The American Iron and Steel Institute reports that approximately 20 rolling mills of various types are under construction or were finished during 1958. Some of these are modernization projects but most of them are new.

The Institute also reports that more than 20,000,000 tons of new annual sintering capacity has been completed this year. Improvement programs also include electric arc furnaces, coke ovens, soaking pits, pipe mills, processing lines of various kinds and many miscellaneous auxiliaries.

△ The new sintering plant recently announced by Jones & Laughlin Steel Corp. for their Aliquippa plant will be 13 ft 2 in. (4 meters) wide, 14 in. wider than the new 12-ft units recently completed at Great Lakes and Weirton.

△ The Value Line Investment Survey says a significant upturn in the machinery industry is under way. New orders are going up and have retraced nearly one-half of the 1956–58 decline. Such expenditures are principally for replacement and modernization, rather than expansion.

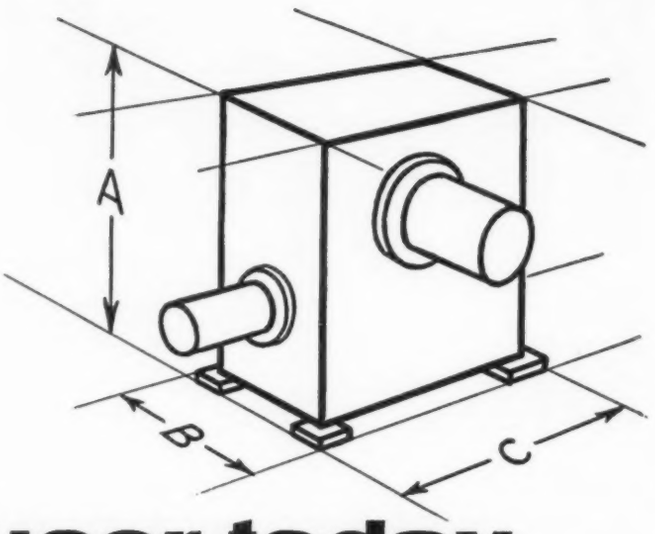
The Survey also sees a 1959 ingot production of more than 111,000,000 tons, with continued growth of industry sales and earnings over the next three to five years.

△ Addressing the San Francisco regional meeting of the American Iron and Steel Institute, B. F. Fairless sees the United States in a dangerous drift toward mediocrity because "we are drifting away from the idea of properly rewarding that individual who does the best job." He believes punitive personal income taxes and the destructive envy of those who do not excel in any endeavor combine to deprive people of high accomplishment of their just rewards.

Mr. Fairless said: "Our race with Russia will not be won by a lot of average students, average scientists or average production workers. We will, however, stay in front as we stimulate top quality, high performance and hard work and provide solid encouragement for everyone to do his very best."

△ Each year it seems a shorter time since we last said it, but here it is again—a merry Christmas and the best of everything for the new year!

Do-It-Yourself...



Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

Does this reduce load capacity? No sir! You can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

Cone-Drive Gears, that's where!

Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

VIEWING FURNACE DROP-OUTS AT JONES & LAUGHLIN'S 44″ HOT STRIP MILL

"Our RCA TV makes furnace charging more efficient–easily paid for itself the first month!"

—says Bob Grimm of J. & L.

RCA Television Camera in weatherproof housing looks into reheat furnace.

The furnace charger on the 44″ mill at Jones & Laughlin's Aliquippa Works, watches his charge of cold slabs enter the furnaces outside of his pulpit and then, on his TV screen, "sees" the heated red-hot 18,000-lb. slabs drop out on the rolling mill approach table 100 feet away! By actually *seeing* the slabs he can avoid pushing more than one slab at a time. He can also keep slabs from getting caught and cooling down on the skids which lead out of each furnace, thus preventing camber and loss of production.

Before using television, the furnace charger simply had his signal lights to depend on. Since the ITV installation, the mill has made new records in rolling. In one hour it has been able to roll as many as 63, 6″ thick slabs, up to 282″ long. "Our RCA closed circuit television more than paid for itself in its first month of use here," says Robert Grimm, Assistant General Foreman. "We have a much more efficient operation as a result, with fewer delays and improved production."

Wherever used, whether for remote observation of mills, shears, furnaces, fuel burners, instruments or gates, RCA closed circuit television is proving its value by increasing efficiency and reducing costs.

RCA Industrial TV is designed and produced to exacting standards by the world leader in electronics.

Tmk(s) ®

RADIO CORPORATION of AMERICA

CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

Mail coupon below for free literature.

Radio Corporation of America
Broadcast and Television Equipment
Dept. N-188, Building 15-1, Camden, N.J.

☐ Please send me latest literature on the use of RCA Industrial TV.

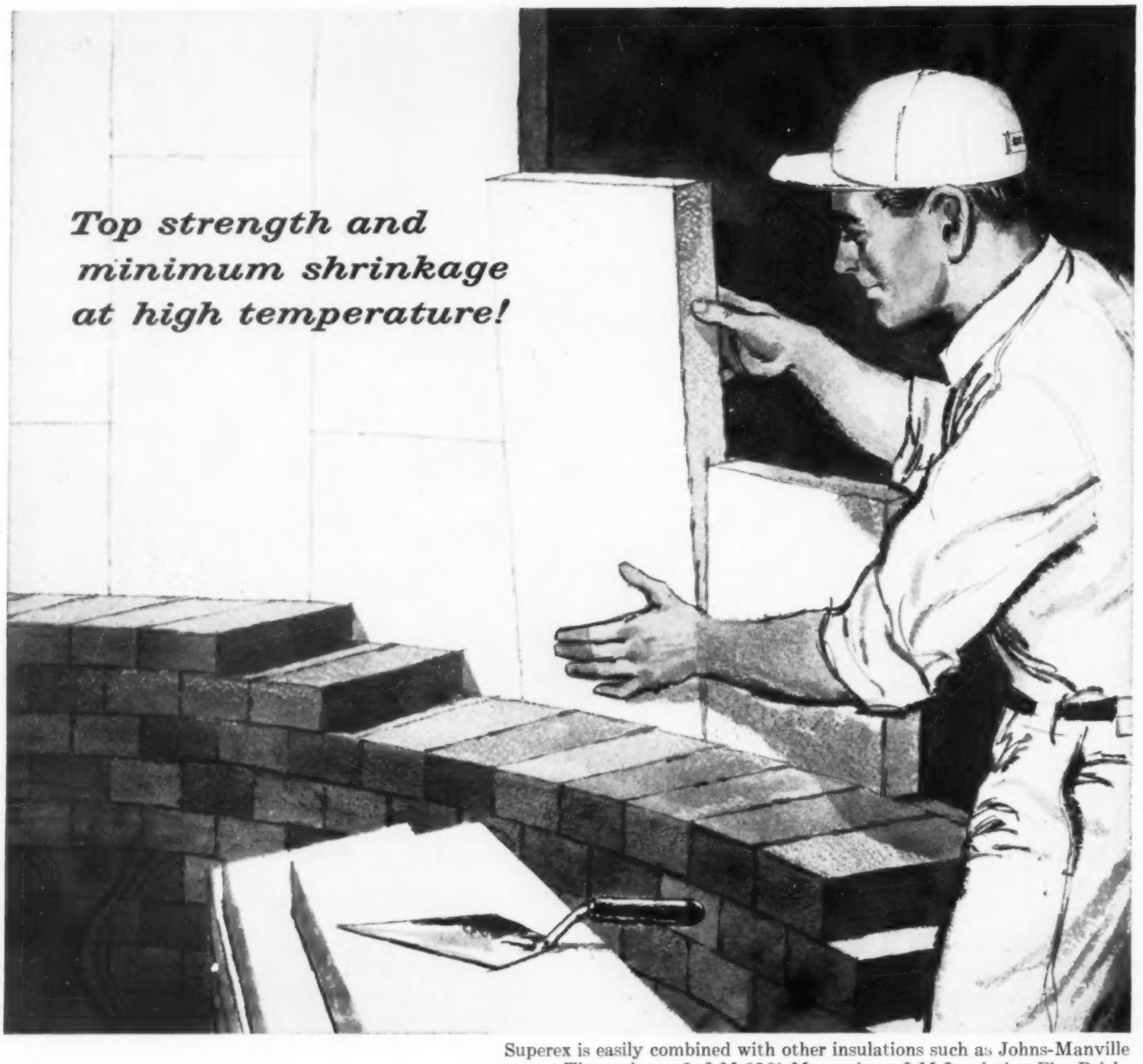
NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

☐ Have representative call.



Superex is easily combined with other insulations such as Johns-Manville Thermobestos®, J-M 85% Magnesia or J-M Insulating Fire Brick.

After a quarter century . . .

there's still no substitute for J-M Superex insulation for service to 1900F!

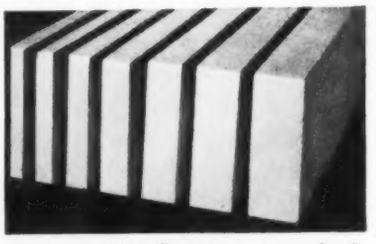
In many ways, Superex® is the finest block insulation yet developed for high temperature furnace applications!

Made of diatomaceous silica and asbestos, Superex offers exceptional heat resistance—excellent insulating value. And at high temperature its stability is unsurpassed: it combines low shrinkage with excellent thermal effectiveness . . . easily withstands the physical abuse encountered in normal service.

Superex also speeds and simplifies installation. *Easy-to-handle*—Superex weighs only 2 lbs. per sq. ft. per inch thickness. *Strong*—it compresses only ⅛ inch under 6 tons' pressure per square ft. Superex is available in a wide variety of shapes and sizes . . . is easily cut with an ordinary knife or saw.

For further information write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

For medium temperature applications, specify J-M Superex M blocks . . . for temperatures to 1600F.



Saves waste. Superex comes in 7 standard thicknesses from 1" to 4". Other sizes available on order.

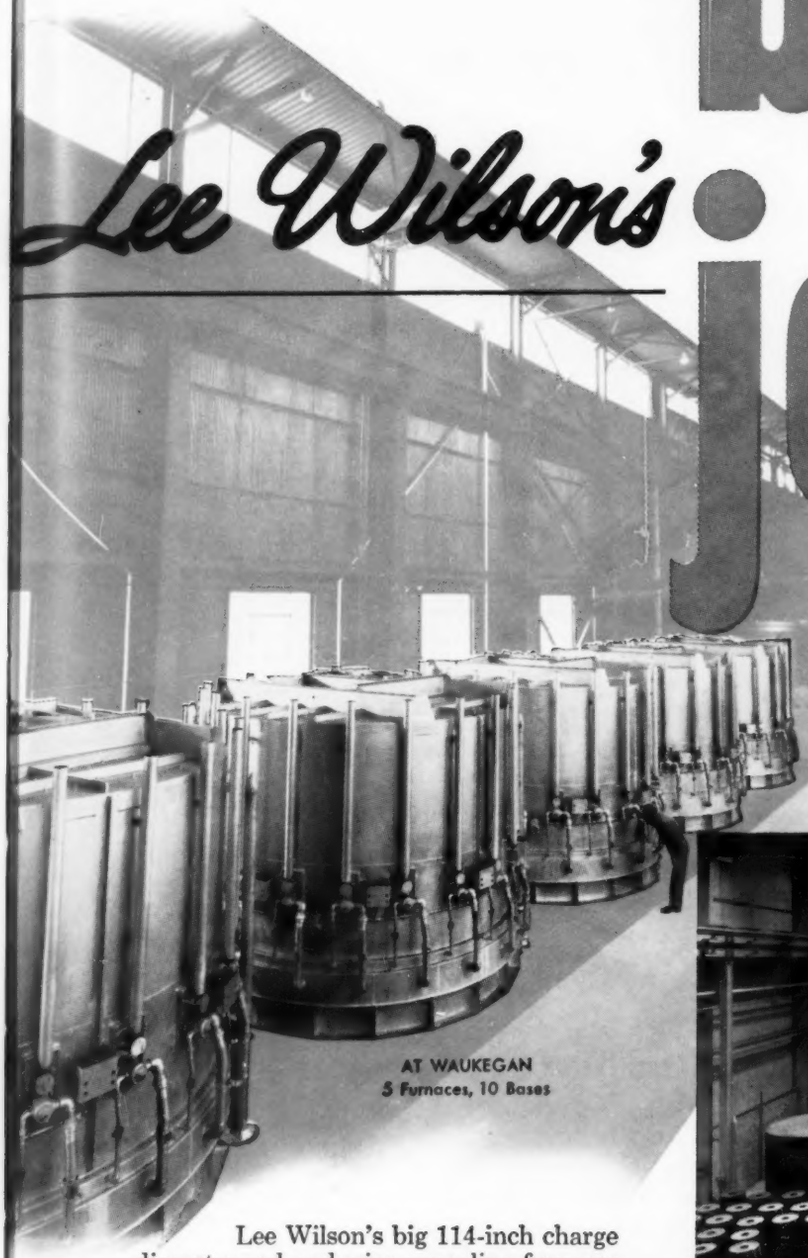
JOHNS-MANVILLE JM PRODUCTS

Johns-Manville INSULATIONS *FOR LASTING THERMAL EFFICIENCY*

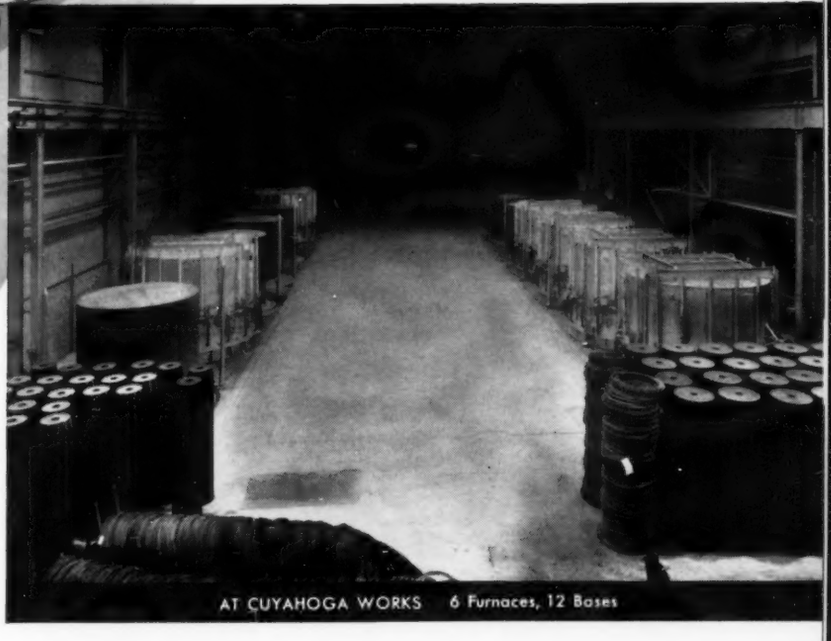
MATERIALS • ENGINEERING • APPLICATION

Lee Wilson's 'big jobs'...

give American Steel and Wire greater productivity, better Rods and Wire



AT WAUKEGAN
5 Furnaces, 10 Bases



AT CUYAHOGA WORKS 6 Furnaces, 12 Bases

Lee Wilson's big 114-inch charge diameter rod and wire annealing furnaces give American Steel and Wire both the speed and quality they require to meet modern-day competition.

The largest furnaces of their type ever built, they will easily take four spiders of heavy rod in a single charge. A high convection system that sends 5 million BTU's per hour is controlled with exacting precision from a central control area.

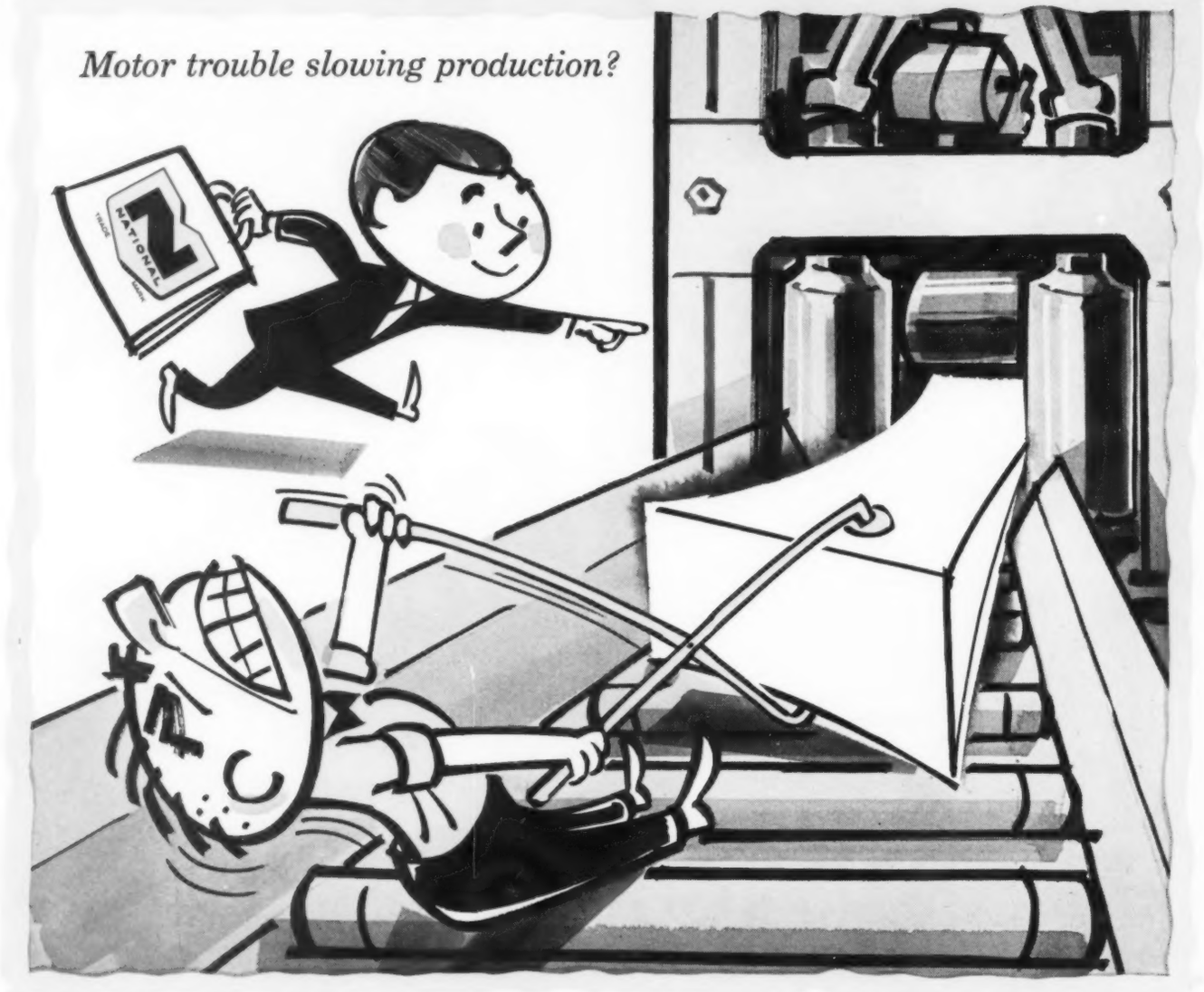
If you're considering investing in new wire annealing equipment, make certain you check first with Lee Wilson—America's most experienced wire and rod annealing equipment manufacturer.

Lee Wilson* ENGINEERING COMPANY, INC.
20005 LAKE ROAD • CLEVELAND 16, OHIO

HIGH CONVECTION ANNEALING FURNACES.
MAKE THE BEST METALS BETTER

*ORIGINATORS AND LEADING PRODUCERS OF HIGH CONVECTION ANNEALING FURNACES

Motor trouble slowing production?



Your NATIONAL TRADE-MARK brush man helped solve this slowdown problem!

JOHN BEHEN

Motor trouble at this 44″ steel mill caused one costly slowdown after another, says "National" Carbon Brush Man, John Behen. Source of the production trouble – excessive film build-up on one of the mill's edger motors.

The mill tried several brushes to alleviate this condition but with no success. They called in John Behen who analyzed the operation and recommended the proper "National" brush grade. *Result:* a 100 ton increase in daily production thanks to trouble-free motor performance. Incidentally, John went on to solve similiar brush problems on 3 of the steel mill's 5,000 amp motor-generator units.

John Behen and his fellow "National" Carbon Brush Men have been solving industrial brush problems for years. Their experience and training – backed by "National" *long term brush development* – make them the logical consultants on any industrial brush problem.

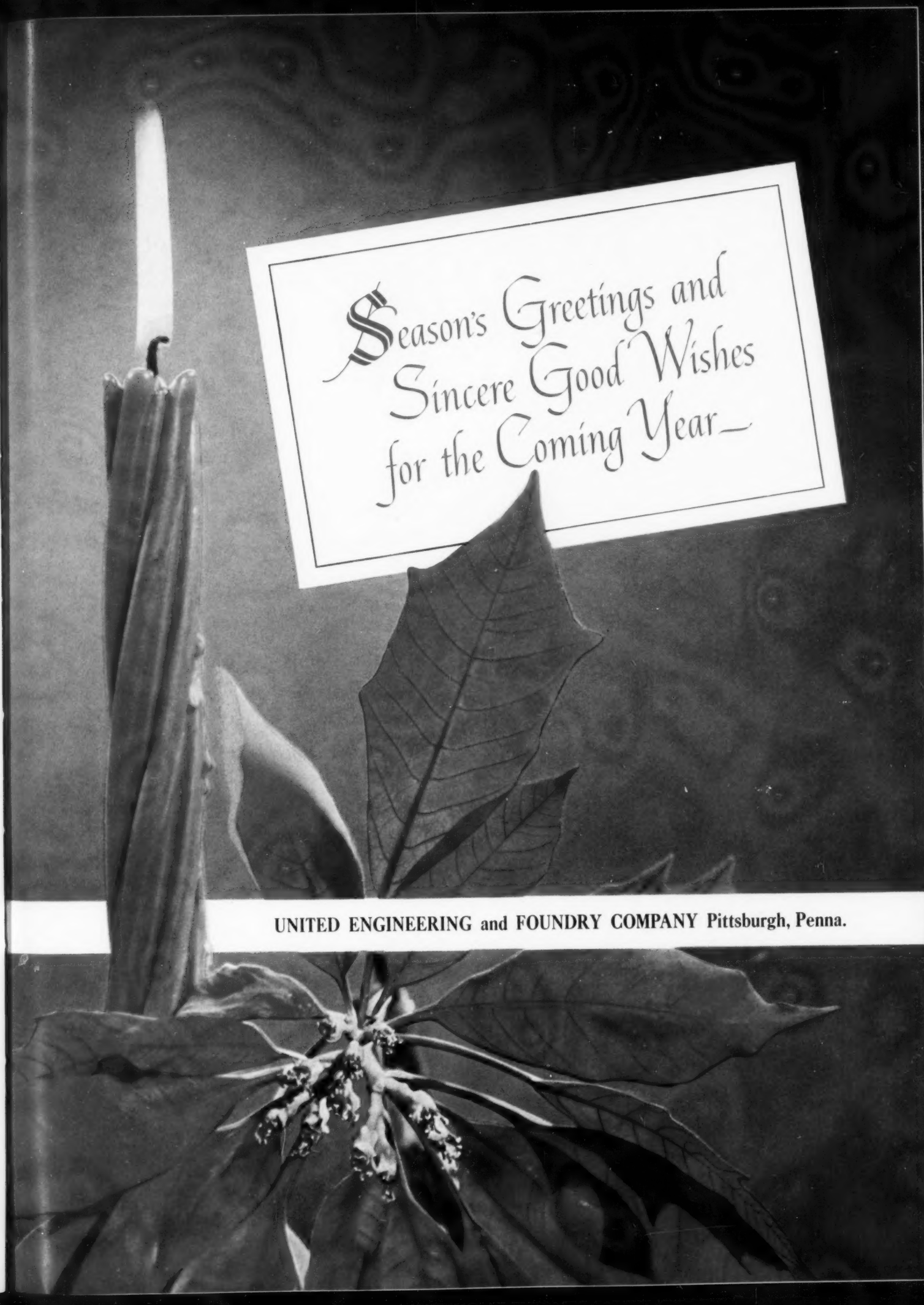
Call your "National" Carbon Brush Man today. Or write National Carbon Company, Division of Union Carbide Corporation, 30 E. 42nd St., New York 17, N.Y.

The terms "National", "N" and Shield Device, and "Union Carbide" are registered trade-marks of Union Carbide Corporation

UNION CARBIDE

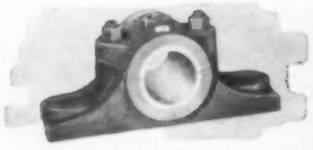
NATIONAL CARBON COMPANY • Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto.

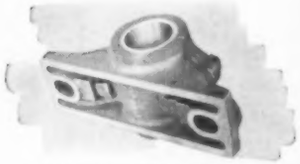


UNITED ENGINEERING and FOUNDRY COMPANY Pittsburgh, Penna.

Before you buy babbitted and bronze bearings . . .
this 6-spot check can help you
pre-judge quality



HOUSINGS are of durable cast gray iron . . . compact, exceptionally strong and rigid. No excess weight.

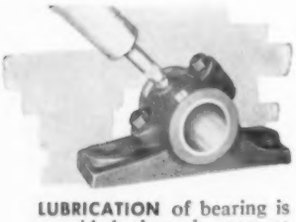


BASES are finished for close tolerance from base to center of bore—assure firm seating on supports.

BORES are finish-machined to close tolerances . . . assure concentricity, accurate fit on the shaft.

ENDS are finished to provide accurate bearing surface for collar or sprocket . . . reduce friction.

BOLT HOLES in base are slotted to permit easy adjustments for accurate shaft alignment.



LUBRICATION of bearing is provided through grooves and fitting in cap.

You'll find these LINK-BELT features in 15 types and more than 300 standard sizes

Look for these features when you buy babbitted and bronze bearing blocks . . . and you can be sure of long-lasting, free-rolling efficiency every time.

In addition to those illustrated, Link-Belt uses a heavy-duty babbitt or high-quality bronze—securely anchored in housing—for long bearing life. What's more, Link-Belt assures off-the-shelf delivery on more than 15 types and over 300 sizes of solid, split, gibbed or angle blocks for shaft sizes from ½ to 8 inches, plus related take-ups. And for special applications, bearings can be furnished with cast steel housings.

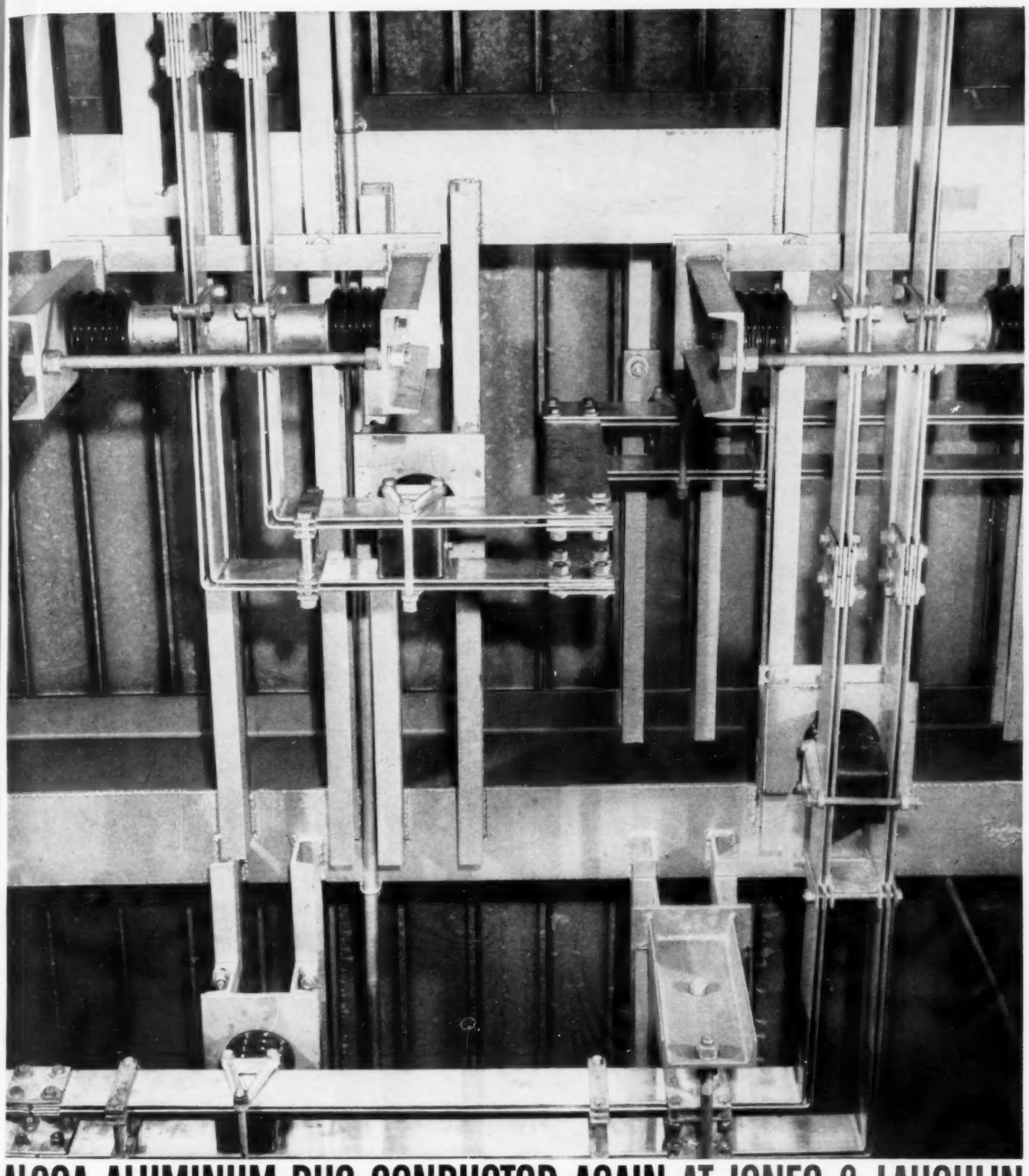
Link-Belt bearing blocks are carefully packed to assure factory-finish condition on delivery. Recessed decals identify bearing blocks by serial number and size . . . simplify ordering. Call your nearest Link-Belt office or authorized stock-carrying distributor. Refer to the yellow pages of your local phone directory.

14,812

LINK-BELT

BABBITTED AND BRONZE BEARINGS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro, (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.



ALCOA ALUMINUM BUS CONDUCTOR AGAIN AT JONES & LAUGHLIN

Jones & Laughlin Steel Corporation *again* used Alcoa® Aluminum Bus Conductor in their Aliquippa, Pa., Hot Strip Mill and saved almost 50 per cent over a comparable copper installation.

The 21-year record in a hot strip mill at their Pittsburgh Works had already proved the satisfactory performance of Alcoa Aluminum Bus Conductor.

Low material cost, low installation and maintenance costs plus easy-to-make, low-resistance connections are strong reasons to use Alcoa Aluminum Bus Conductors in the steel industry. Immediate delivery of rectangular bus conductor in popular sizes is available from your Alcoa Distributor. Call him before completing plans for plant modernization or expansion. Or write, Aluminum Company of America, 2310-M Alcoa Building, Pittsburgh 19, Pa.

DISTRIBUTORS OF ALCOA ALUMINUM BUS

Brace-Mueller-Huntley, Inc.	Pacific Metal Co.
The Corey Steel Co.	Pacific Metals Co., Ltd.
Edgcomb Steel Co.	The J. M. Tull Metal & Supply Co., Inc.
Ducommun Metals & Supply Co.	Williams & Co., Inc.
Metal Goods Corp.	Whitehead Metal Products Co., Inc.

Four ¼" x 6" Alcoa Aluminum Bus Bars carry 5,000 amps maximum at 750 volts to finishing stand motors at Jones & Laughlin's Aliquippa Works.

Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM
ELECTRICAL CONDUCTORS AND ACCESSORIES

ALCOA THEATRE
Fine Entertainment
Alternate Monday Evenings

GENERAL ELECTRIC ANNOUNCES . . .

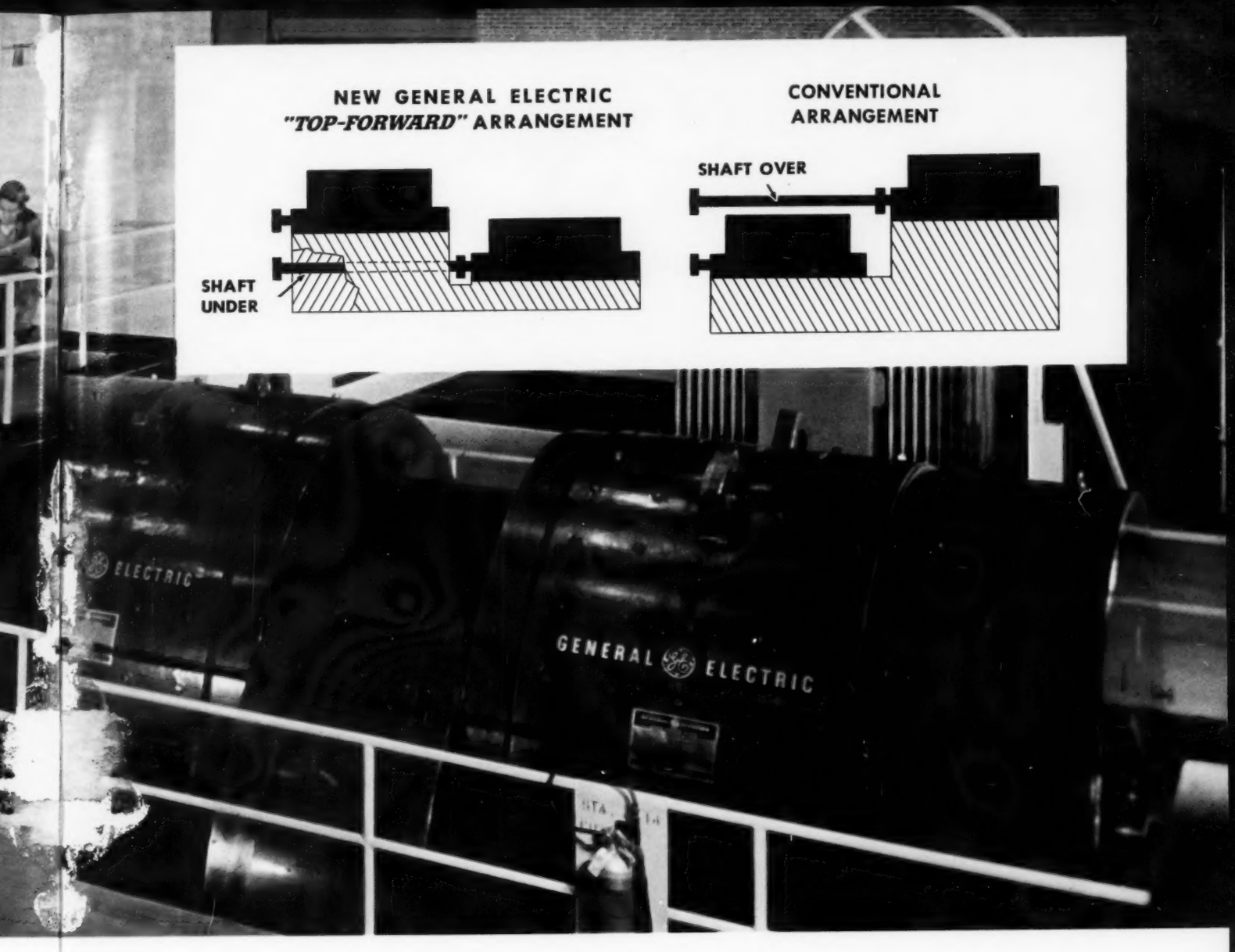
Revolutionary Redesign for M

With "ease of maintenance" as the major criterion, General Electric engineers recently completed the dramatic redesign of large direct-current motors for metal rolling mill applications.

The result of a complete re-analysis of industry drive requirements, the new standard G-E metal rolling mill motors are forced ventilated, and are furnished with enclosing covers and Class B insulation throughout.

REVOLUTIONARY *"TOP-FORWARD"* twin-drive arrangement exemplifies G.E.'s emphasis on "ease of maintenance." The top motor is located nearest the mill with the rear motor shaft running underneath. This unique arrangement makes both motors more accessible for fast, easy maintenance, and substantially reduces installation and construction costs.

Other extra-value features available now include quick-removable air shields, which eliminate



or Metal Rolling Mill Motors

time-consuming unbolting; constant-pressure brush holders, requiring no brush pressure adjustment; use of self-locking nuts and bolts to fasten internal components; and built-in inspection light, utility outlet, plus many other features designed to make maintenance faster, easier.

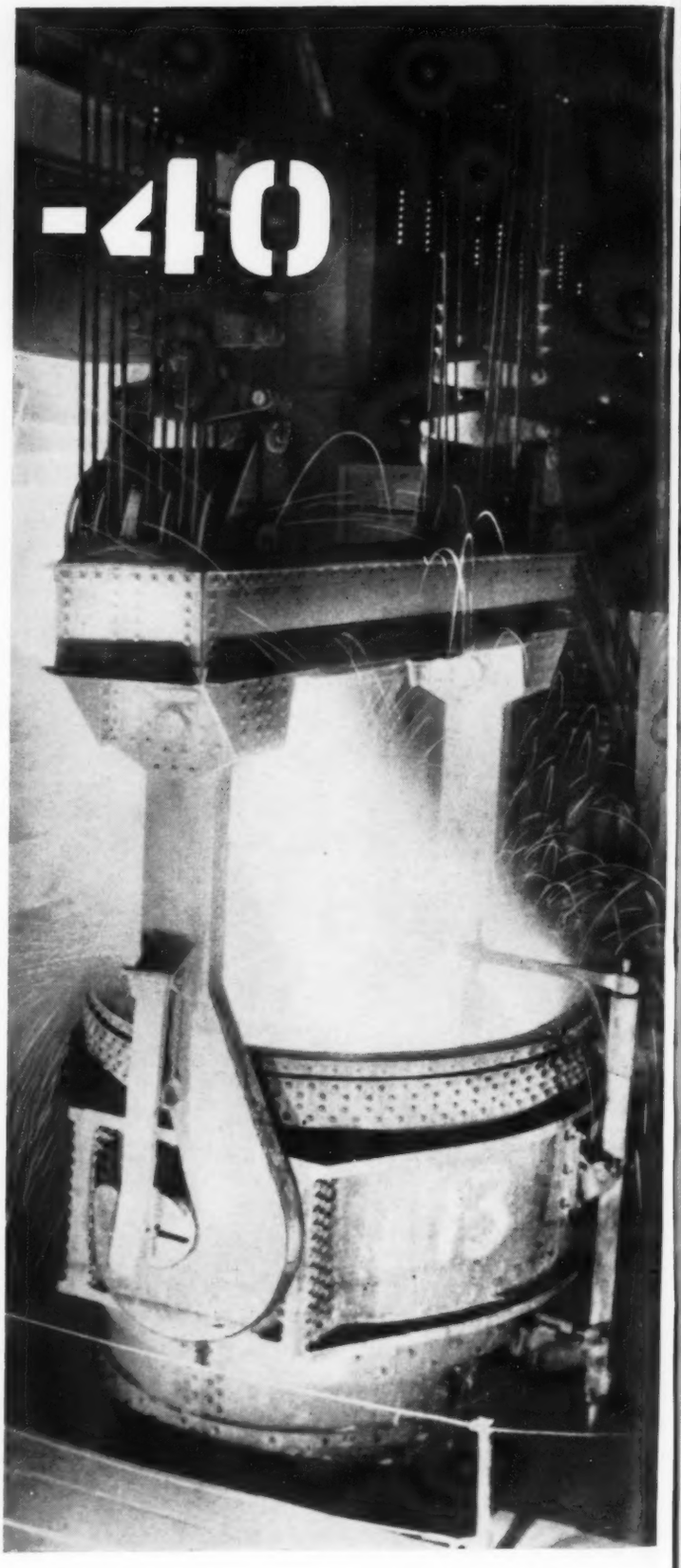
A COLORFUL NEW BROCHURE, GEA-6812, "D-c Drives for Metal Rolling Mills," describes this revolutionary new design. Contact your nearest General Electric Apparatus Sales Office, or write for it today. General Electric Company, Section 772-6, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

TAYCO-40

---no better cement for silica masonry!



TAYCO-40 Silica Cement increases the life of silica brick roofs in direct arc and open-hearth furnaces. The major steel mills find it economical to use TAYCO-40 for laying up silica and super-duty silica brick in furnace roofs. It is also used to advantage with silica and semi-silica brick and silica stone in soaking pits; with semi-silica brick in open-hearth regenerator walls and roofs.

THE ADVANTAGES OF **TAYCO-40** ARE MANY:

1. **TAYCO-40** will **not** run out of joints at temperatures up to 3100°F.

2. Silica brick and shapes are more easily fitted, with all voids and irregularities well filled.

3. Roof life is prolonged. Thin, tight joints prevent brick from slipping out of place when in service. Spalling is retarded.

4. **TAYCO-40** has excellent water retention and smooth workability. Use it for dipped, poured or trowelled joints. Less cement is used; joints are thinner and tighter.

Try TAYCO-40 Silica Cement for your next furnace re-build. Properties and service data are given in Bulletin 507. Write for your free copy.

The **CHAS. TAYLOR SONS** Co.
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U.S.A.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal

NEVER OVERLOOK THE DANGER OF EXPLOSIVE DUST...

Some of the most disastrous explosions in industrial history occurred through the ignition of dust suspended in plant atmosphere—some of them dusts which were thought to be perfectly harmless. *Until they exploded.*

The moral is clear: If you can see quantities of dust in your plant, *it's dangerous.*

Crouse-Hinds dust-tight* Condulet equipment seals off electrical sparks and prevents ignition of air-suspended dusts. It is designed to minimize the accumulation of dust on outer surfaces. As an added precaution, it is built to operate at a temperature below dust-ignition points *even when blanketed with dust.*

The new Crouse-Hinds "Hazard Finder" will help locate the hidden probabilities of electrically-ignited explosions in your plant. It reflects, in non-technical language, the latest findings of the National Fire Prevention Association for thorough control of electrical explosion hazards. Just clip coupon below.

*Dust-ignition-proof.

Crouse-Hinds Dust-tight Lighting Fixture

Crouse-Hinds Dust-tight Panelboard

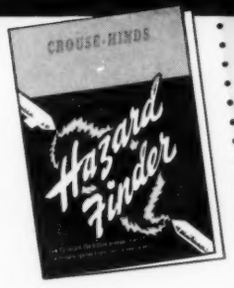
● **CONDULET® ELECTRICAL EQUIPMENT** — More than 15,000 items in dust-tight, explosion-proof or conventional construction . . . including rigid conduit fittings, lighting fixtures, switches, plugs and receptacles, motor controls, pilot lights, push-button stations, and other process control components.

CROUSE-HINDS COMPANY
SYRACUSE 1, N. Y.

Crouse-Hinds products are sold exclusively through electrical distributors.

Send coupon today for handy new HAZARD FINDER!

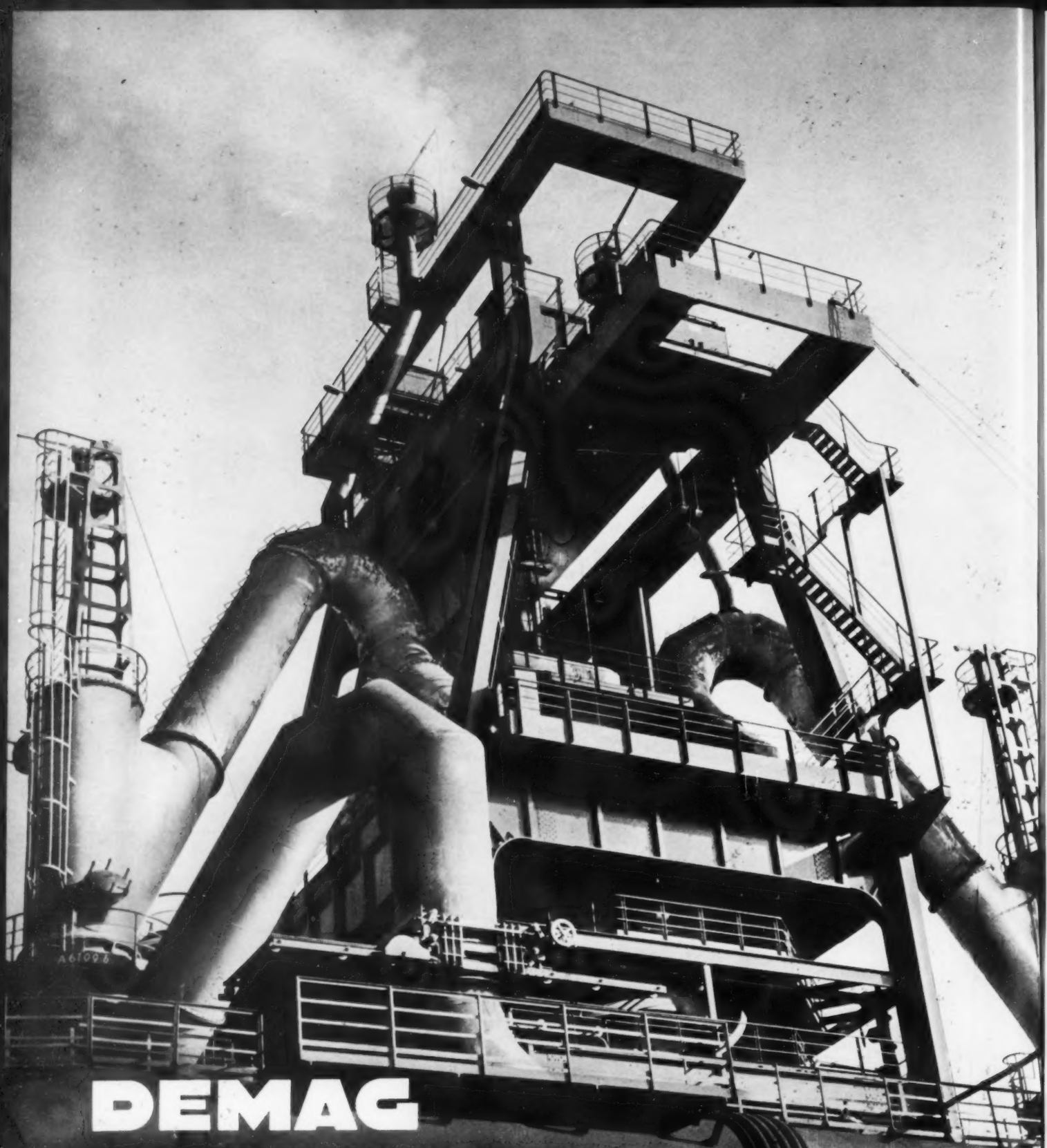
Contains 13 check questions to which every management team should know the answers! Each answer evaluated in accordance with National Electrical Code requirements.



CROUSE-HINDS COMPANY
1205 Wolf St., Syracuse 1, N. Y.

Send me your Hazard Finder.

Name_____
Position_____
Company_____
City_____
Zone_____ State_____



DEMAG

THE »NEW LOOK« IN BLAST FURNACE DESIGN

Blast furnace plant of a west-German integrated iron and steel works, comprising two skip-charged blast furnaces built by DEMAG, with frame and inclined hoist of welded plate and a self-supporting furnace shell. Daily capacity 500 tons.

U. S. Representatives:
AMERICAN DEMAG CORPORATION, one Gateway Center, Pittsburgh 22, Pa.

DEMAG AKTIENGESELLSCHAFT DUISBURG GERMANY

patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period July 1, 1958 through July 29, 1958.

BENEFICIATION OF IRON ORES

△ U. S. 2,843,472, issued July 15, 1958 to John E. Eberhardt and assigned to Bethlehem Steel Co., describes a process for the beneficiation of iron-bearing ores of the type containing other oxides, such as chromium, nickel, cobalt, and manganese (e.g., Mayari type ores).

The invention is based on the use of hydrochloric acid gas and/or chlorine to produce ferric chloride according to the equations:

$$Fe_2O_3 + 6HCl \rightarrow 2FeCl_3 + 3H_2O$$

$$2Fe_2O_3 + 6Cl_2 \rightarrow 4FeCl_3 + 3O_2$$

when energy in the form of heat is applied to form ferric chloride vapor and water vapor and/or oxygen. Then the temperature of the vapors is increased according to the water vapor and/or oxygen content to produce ferric oxide and hydrochloric acid gas and/or chlorine in accordance with the equations:

$$2FeCl_3 + 3H_2O \rightarrow Fe_2O_3 + 6HCl$$

$$4FeCl_3 + 3O_2 \rightarrow 2Fe_2O_3 + 6Cl_2$$

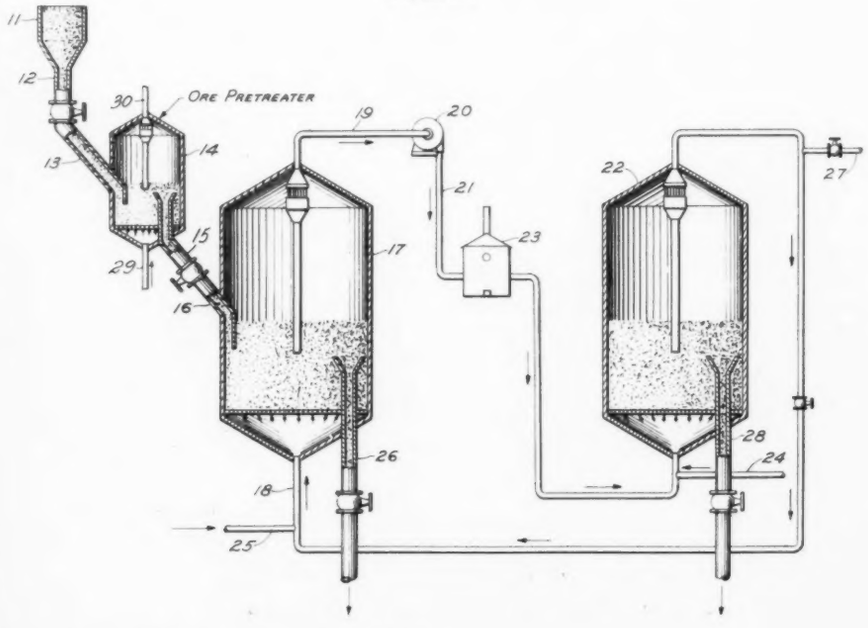
The invention utilizes the fact that the boiling point of ferric chloride is considerably lower than the boiling points of the chlorides of most of the nonferrous metals which are commonly associated with iron in iron ores. The approximate boiling point of ferric chloride is 607 F. Following is a list of the approximate boiling points of the chlorides of certain other metals found in various iron bearing ores:

Compound	*Boiling point, F*
$CrCl_2$	2312
$CrCl_3$	1760
$NiCl_2$	1810
$CoCl_2$	1920
$MnCl_2$	2180

While the boiling points of aluminum chloride and silicon chloride are considerably lower than the boiling point of ferric chloride, it has been found that the chlorine of the gases does not combine with the alumina and silica contents of the ore and they remain in the residue in their natural condition as they appear in the ore after the ores have been calcined and/or somewhat reduced.

As shown in Figure 1, finely divided Mayari ore in bin 11 is fed through conduits 12 and 13 into the ore pretreating chamber 14. A pretreating gas may be supplied to pretreater 14 through line 29 and exhausted through line 30. From this pretreating chamber the ore is fed through the conduits 15 and 16 into the chloridizing chamber 17 where the ore is subjected to the action of a hot gas consisting predominantly of hydrochloric acid which enters the bottom of the chamber through pipe 18. The temperature of the ore which enters this chloridizing chamber and the temperature of the gas which enters this chamber are such that the ore in the chloridizing

Figure 1



chamber is maintained at about 1100 F. Under these conditions ferric chloride and water are formed, volatilized and commingled with the gas. The gas, containing ferric chloride and water vapors, is drawn from the top of the chloridizing chamber through pipe 19 by means of pump 20, the gas then passing through pipe 21 to the gas reaction chamber 22. On its passage through pipe 21 the temperature of the gas is increased by the gas heater 23 through which the pipe 21 passes. The increase in the temperature of the gas containing the vapors of water and ferric chloride causes the formation of ferric oxide, hydrochloric acid and chlorine. This reaction starts in pipe 21, at the location of the gas heater, but the principal amount of chemical change occurs in the reaction chamber 22. The ferric oxide produced is in the solid phase and drops into the lower part of the reaction chamber 22 and thus is separated from the gas. The greater part of the gas, now containing increased amounts of hydrochloric gas, then returns to the chloridizing chamber through the closed system indicated on the drawing. The system is started and replenished by entering appropriate gas or gases through pipe 18. The other solid constituents of the ore plus unvaporized chlorides of other metals present leave chamber 17 through pipe 26. Bleed-off valve 27 may be used if needed to vent the system of impurities or to keep the system in balance. Solid ferric oxide leaves reaction chamber 22 through pipe 28.

OTHER PATENTS OF INTEREST IN THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,840,872	7/1/58	Introduction of zirconium into steel	Sharon Steel Corp.
2,840,890	7/1/58	Stainless steel wire coating	Armco Steel Corp.
2,841,488-9	7/1/58	Nodular cast iron	The International Nickel Co., Inc.
2,841,490	7/1/58	Production of spheroidal graphite in cast iron castings	The International Nickel Co., Inc.
2,841,502	7/1/58	Tap hole and bessemer bottom mix	The Ilinois Clay Products Co.
2,842,352	7/8/58	Apparatus for handling work in a furnace	Leeds & Northrup Co.
2,842,353	7/8/58	Slag ladle	Michael J. Priola
2,842,423	7/8/58	Separation of acid gases from coal carbonization gases	Herbert A. Golliner
2,842,434	7/8/58	Beneficiation of low grade iron ore	Trans-Oceanic
2,842,435	7/8/58	Stripping of tin coatings from iron or steel articles	Western Electric, Inc.
2,842,437	7/8/58	Austenitic modular iron	Compagnie de Pont-a-Mousson
2,842,821	7/15/58	Ingot stripping and storage device	The Alliance Machine Co.
2,843,179	7/15/58	Roll forming apparatus for metallic strip	Armco Steel Corp.
2,843,898	7/22/58	Hot top	United States Steel Corp.
2,844,498	7/22/58	Method for surface-hardening of steel	Nicolas Mouravieff
2,845,229	7/29/58	Apparatus for spooling wire	United States Steel Corp.
2,845,342	7/29/58	Recovery of ferrochromium	Strategic-Udy Metallurgical & Chemical Processes Ltd.
2,845,345	7/29/58	Low-alloy high-strength steel	United States Steel Corp.
2,845,385	7/29/58	Coke oven battery	Koppers Co., Inc.

CONTROLLING THE BATH TEMPERATURE IN A BLAST FURNACE

△ U. S. 2,845,343, issued July 29, 1958 to Kuro Kanamori, assigned in part to Yawata Seitetsu K. K. (Stock Company), describes a method for controlling the bath temperature in a blast furnace.

In the present invention, the bath temperature is controlled by directly adjusting the temperature of the molten pig iron in the blast furnace by feeding under pressure oxygen, nitrogen, carbon dioxide, water vapor and/or water through a pipe which is inserted into the molten pig iron in the bath through an inclined tuyere arranged at the slagging hole or the furnace wall.

The oxygen fed as above acts to increase the bath temperature by subjecting the silicon, manganese, carbon, etc., contained in the molten pig iron, to combustion, and the other substances fed as above act to deprive the pig iron of heat through physical and chemical reactions such as conduction, evaporation, dissociation, etc., so that it is possible to adjust at will the temperature of the molten pig iron by varying the mixing ratio of said substances.

As shown in Figure 2, when water is applied to the operation, a blow pipe 3 is inserted into the bath through the inclined tuyere 2 of the blast furnace. Pipe 3 is employed so that oxygen and inert gas may be blown into the molten pig iron 4, and water may be added through a connecting pipe 6 from a water tank 5.

The apparatus for measuring the bath temperature, as shown in Figure 3, consists of a carbon pipe 7 inserted into the molten pig iron 4 through the wall hole 8 made in the furnace. The end temperature of pipe 7 can be measured through the upper opening 9 by a pyrometer, so that the temperature of the molten pig iron can be measured.

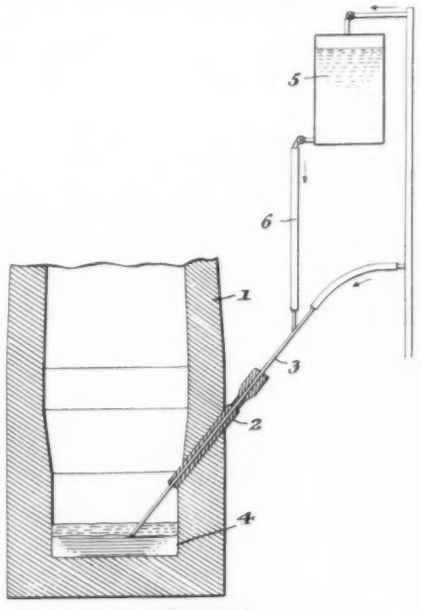
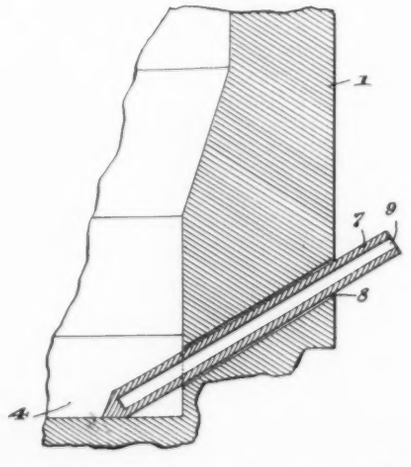


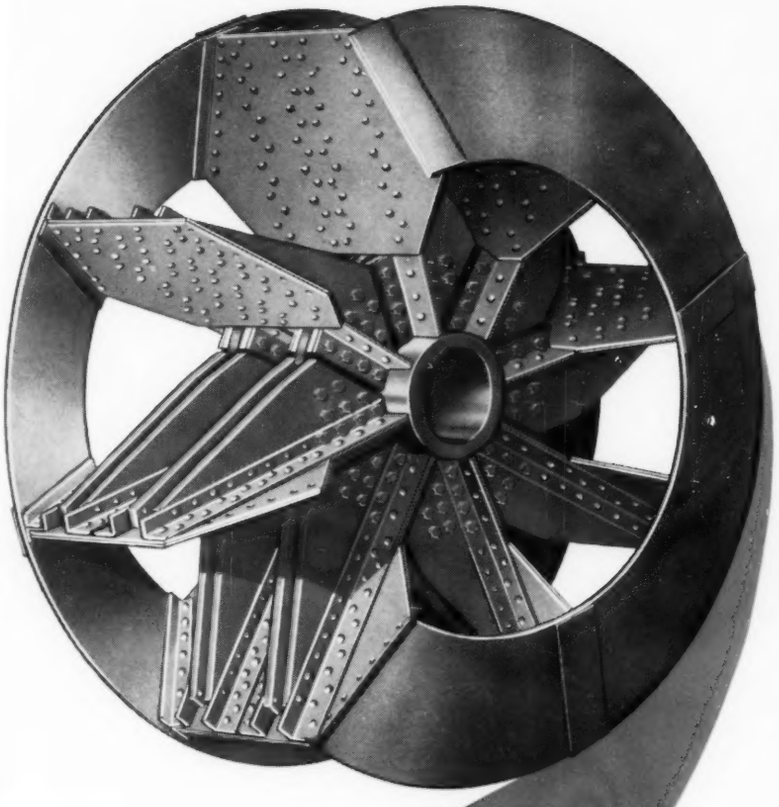
Figure 2

Figure 3



HOT TOP

△ U. S. 2,841,843, issued July 8, 1958 to Henri Nouveau, assigned to



Here's a rugged giant of a fan for sintering!

Green *Sintering Fans*

Specially Developed To Withstand Punishing Everyday Operation

This fan won't punch a time clock! The heavy duty battleship construction and extreme erosion resistance assures you dependable service and *longer life*.

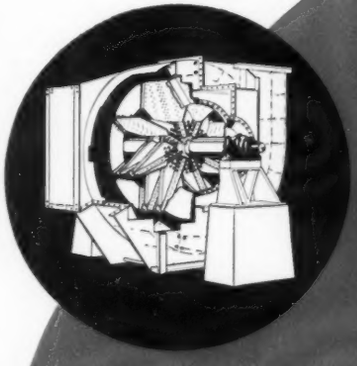
CUSTOM ENGINEERED: No Green Sintering Fan is a stock fan. Each Green Sintering Fan is specifically designed and engineered to meet your particular requirements.

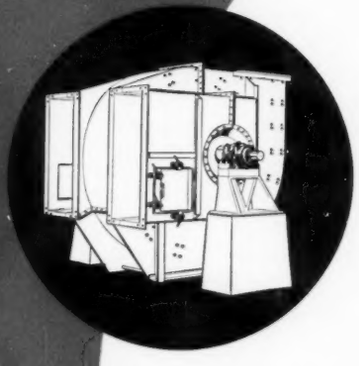
Careful stress studies of every cubic inch of material in a Green Fan are made to meet the tip speeds of 30,000 fpm, or more, necessary for pressures required in sintering.

EROSION RESISTANT: Erosion of fan blades is a serious and ever present sintering problem. Green Fans are designed to keep necessary maintenance time and expense to a minimum. With unique blade design and thick blade liners, erosion problems are drastically lessened. Green blade liners, incidentally, may be replaced without the removal of the rotor.

BUILT-IN SAFETY: Green Sintering Fans are designed to limit operating speed to 66⅔% of first critical speed. Material safety factor at operating temperature is never under 2.

Green custom designed Sintering Fans offer you minimum annual expense and maximum dependability. Write for information and details.





A major steel producer has installed six of these Green Sintering Fans. Each fan produces 360,000 cfm at 35 in. static pressure at 360° F.

Green

THE GREEN FUEL ECONOMIZER CO., INC.

BEACON 3, NEW YORK

S. A. R. L. Doittau Produits Metallurgie, discloses a hot top which uses an exothermic material as the lining of the feed-head frame of the ingot mold.

It is known that it is possible to calculate mathematically the weight of exothermic material required for heating the feed-head so as to ensure a uniform feed of metal to the ingot. Each exothermic material has in fact a specific useful calorific value, but independently of the calorific value, the exothermic material must have particular characteristics according to the case in question, these characteristics being reactivity, that is to say: the time at the end of which the combustion of the exothermic material begins, and the duration of combustion.

In exothermic materials, the longer the starting delay of the reaction, i.e., the weaker the reactivity, the longer is the duration of the combustion of the material and the lower is the quantity of heat which a given mass of the said material is capable of liberating. Therefore, with the former methods, since the supply of heat and the duration of the combustion period were given, it followed almost of necessity that combustion started well before the instant when it would have been useful and/or ended after the useful period.

It has therefore seemed indispensable to make the reactivity, i.e., the time at the end of which the combustion starts under the action of the heat evolved by the molten metal, on the one hand, and the calorific value of the exothermic material and the duration of combustion, on the other hand, independent of one another. This result is achieved by the method according to the present invention.

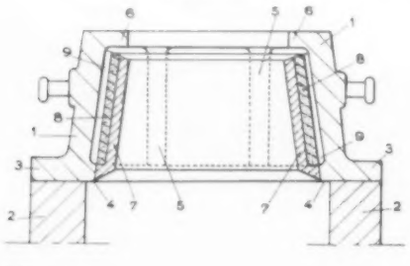
The present invention provides a method of using exothermic materials, in the form of a lining for the wall of the feed-head frame or of the ingot mold, wherein a layer of inert material is interposed between the exothermic product and the molten metal.

With this method, the latent heat of the metal constituting the feed-head of the ingot is only transmitted to the exothermic material through the layer of inert material.

The period of time at the end of which the combustion of the exothermic material will commence is therefore a function of the nature, and more especially of the coefficient of heat conductivity, of the inert material and of the thickness of the layer of said material. Therefore this period can in this manner be made independent of the properties of the exothermic material itself.

Figure 4 shows one embodiment of the invention, in which the lining consists of four trapezoidal slabs. The slabs are formed of a layer of insulating material 7 facing the interior of the ingot mold and lined at the feed-head frame side with a layer of exothermic material 8. The exothermic material can be applied directly against the wall of the feed-head frame but in order to prevent excessive heat loss it is preferable to form, between the exothermic material and the wall, an air gap 9 which acts as a heat insulation means.

Figure 4



GAS SEAL FOR BLAST FURNACE TOPS

△ U. S. 2,843,402, issued July 15, 1958 to George Hookham, assigned to John Miles & Partners (London) Ltd., describes an improved sealing device between the rotating members of a blast furnace top.

Figure 5 shows a normal blast furnace which includes a stack 10 having an open mouth in which is secured a large hopper 11 projecting downwardly into the mouth of the furnace and having its lower end closed by the large bell 12.

This bell is conical in shape and is carried by a rod 13 the upper end of which is hung on a quadrant chain 14 and lever 15 by which the bell 12 can be raised and lowered to close and open the furnace mouth.

The large hopper 11 is covered over by a conical roof 16 having a central aperture in which is fixed a short length of cylinder 16A extending upwardly from the roof.

Seated in this cylindrical portion of the large hopper is a small hopper 17 in the form of a cylinder which is

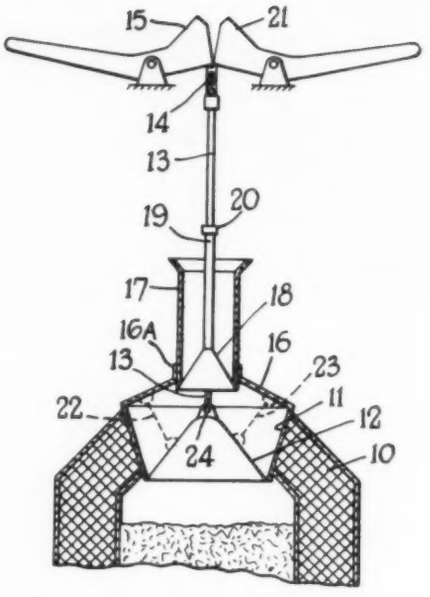
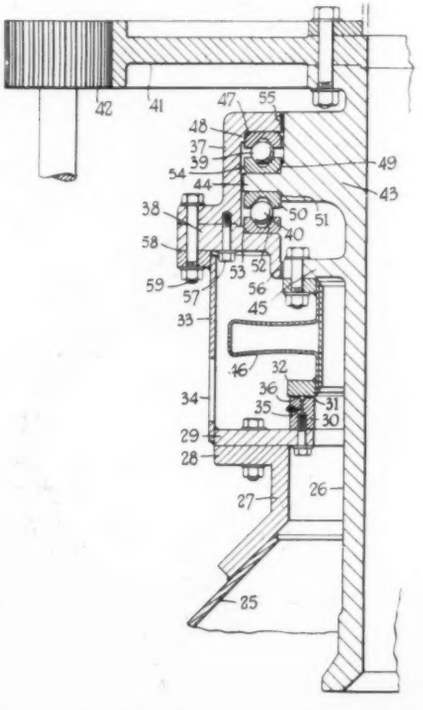


Figure 5

rotatable with respect to the large hopper. The lower end of the small hopper 17 extends downwardly inside the fixed cylindrical portion of the large hopper and the lower end of the small hopper is closed by a small conical bell 18 secured to a tubular sleeve 19 surrounding the large bell rod 13 and movable independently.

For this purpose the sleeve 19 is provided at its upper end with a ballbearing 20, the casing of which is connected by links (not shown) to a lever 21 with which the small bell 18 is raised and lowered.

Figure 6

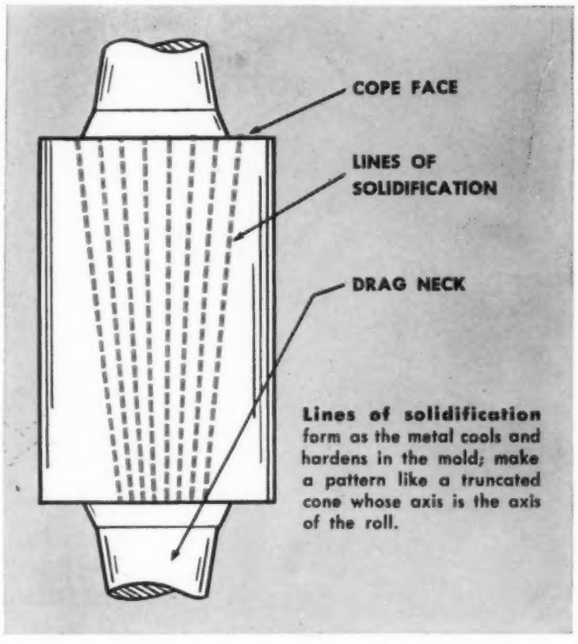


TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

What we learn from "fingerprinting" a back-up roll


COPE FACE
LINES OF SOLIDIFICATION
DRAG NECK
Lines of solidification form as the metal cools and hardens in the mold; make a pattern like a truncated cone whose axis is the axis of the roll.

"Cope face spot depth" sounds a little mysterious, but actually it is a relatively simple, accurate guide to the future performance of back-up rolls in 4-high mills. Even more important, when the roll maker keeps sulfur print records of the spot depth on every back-up roll he ships, it is possible to relate the pattern of the print to the actual tonnage turned out by the roll, as reported by the customer. With this information at hand, Mack-Hemp metallurgists can modify the alloy "mix" or the foundry practice so that the next set of back-up rolls will give even better service.

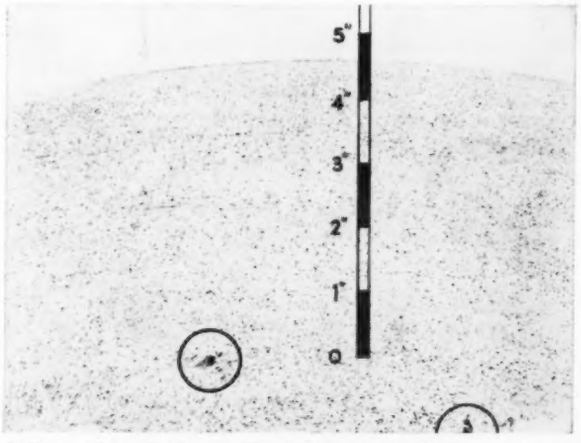
What "cope face spot depth" reveals—As a freshly-poured Mack-Hemp "Technalloy" or "Midland Superalloy" steel back-up roll cools and hardens, so-called "lines of solidification" form below the surface of the roll (see diagram). These lines arrange themselves in a cone-shaped pattern spreading outward as they ascend from the "drag" wabbler toward the upper shoulder of the roll body, or "cope face." The points where the lines of solidification end in the cope face can be detected by an acid etch, and a permanent record made by laying special photographic paper over the etched area.

As you can see, the depth of this zone of dense metal is shallowest at the cope face because of the way the lines angle outward. Hence, cope face spot depth provides a measure of the minimum amount of sound, homogeneous metal between these lines of solidification and the work surface of the roll.

Spots should be deep—In general, the roll maker's objective is to keep the spots on the cope face as deep as possible below the worn-out circumference of the roll. However, sheer depth is not the only indication of the roll's life expectancy and behavior in service. The arrangement and density of the spots also tell their story to the trained metallurgist, particularly when he studies them in the light of performance data from the customer and foundry practice at Mack-Hemp.

* * *

You can see why it's a good idea to keep careful records of tonnages rolled by your Mack-Hemp hot and cold mill back-up rolls. It's a good idea, too, to consult Mack-Hemp on any and all your problems of roll use and selection whenever they arise. Feel free to call or write us at any time.



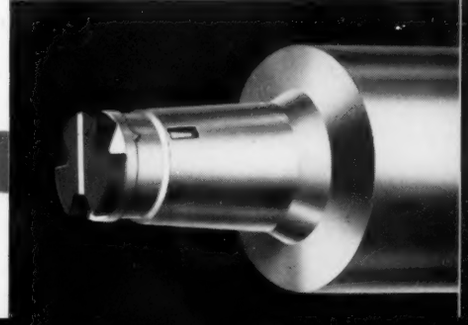
Sulfur print of "Superalloy" back-up roll. Two spots are clearly evident at the bottom of the print (⅓ actual size).

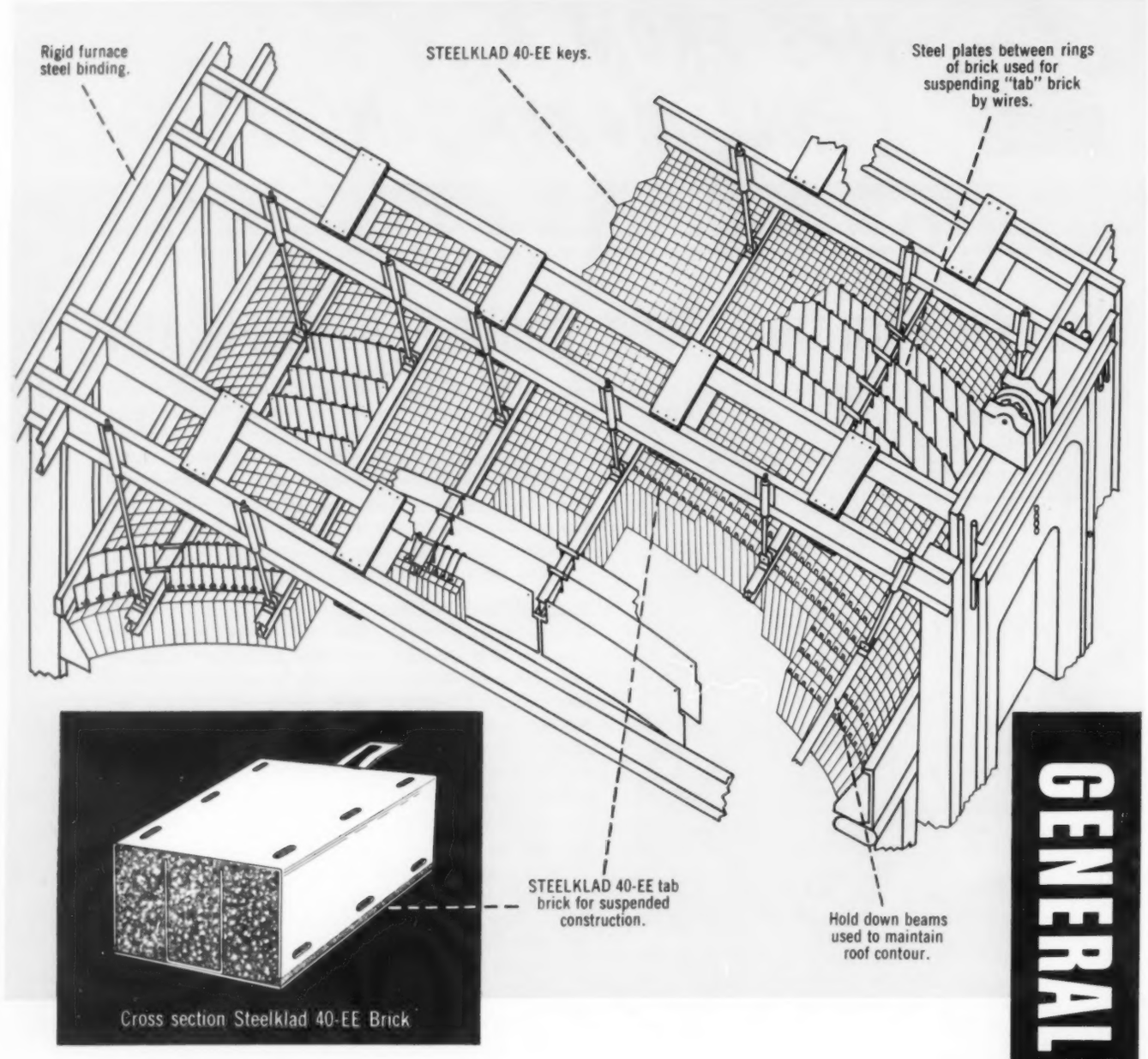
MACKINTOSH-HEMPHILL

You get more tonnage from the rolls with the Striped Red Wabblers

Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery




Rigid furnace steel binding.
STEELKLAD 40-EE keys.
Steel plates between rings of brick used for suspending "tab" brick by wires.
STEELKLAD 40-EE tab brick for suspended construction.
Hold down beams used to maintain roof contour.

Cross section Steelklad 40-EE Brick

Breakthrough in Steelmaking...

Basic refractory brick—pioneered by Grefco—has produced a breakthrough in modern steelmaking. Previously, the advantages of greater steel production at lower cost, brought about by improved operating techniques and greater use of oxygen, were largely offset by the fact that conventional refractories could not withstand the far higher temperatures and stresses that resulted. Only "All-Basic" furnaces (i.e., furnaces completely lined with basic refractory brick) can endure these more punishing production schedules without costly shutdowns for repairs.

As a result, there are or soon will be in operation in North America more than 75 "All-Basic" furnaces with roofs of GREFCO "STEELKLAD 40-EE", the original internally-plated basic brick.

Grefco technical and sales service personnel will be glad to provide you with the basic brick exactly tailored to your needs, and with the know-how and experience that make Grefco the industry leader in basic refractories.

GENERAL REFRACTORIES COMPANY
Philadelphia 2, Pa.

A COMPLETE REFRACTORIES SERVICE

GENERAL REFRACTORIES

The two bells and their respective hoppers are used to permit charge materials to be lowered into the furnace without the escape of any substantial quantity of gas from the furnace, and the small hopper is rotated intermittently in order that the charge carried by it may be distributed more uniformly in the furnace.

It has been found, however, that the parts frequently distort in shape with the result that one hopper becomes eccentric with respect to the other.

In Figure 6, a portion of the roof of the large hopper is shown at 25 and a portion of the rotatable cylindrical small hopper at 26.

The roof 25 is permanently stationary and to it is attached a short cylindrical extension 27 formed with an external flange 28 to which is bolted an annular plate 29 carrying a bearing ring 30 the upper surface 31 of which bears against an upper bearing ring 32 rotatable with the small hopper 26.

At its upper end the casing 33 is bolted to a housing consisting of two rings 37, 38 for a pair of annular ballbearings indicated generally at 39 and 40.

The rotatable small hopper 26 has bolted to its upper end a ring gear 41 meshing with a pinion 42 by which it may be rotated periodically.

Below the boss 43 the small hopper is formed with an external flange 45 to which is bolted an expansion bellows 46 carrying at its lower end the upper bearing ring 32.

The bellows is compressed to ensure that rubbing contact is permanently maintained between the two rings 30 and 32.

The only point at which gas can escape is between the two rings 30 and 32 and any small quantity thus escaping passes to atmosphere through the apertures such as 34.

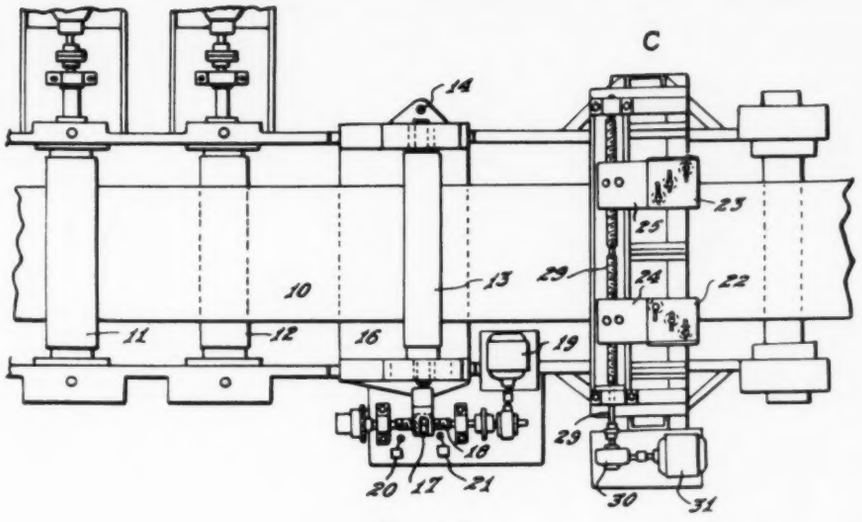


Figure 7

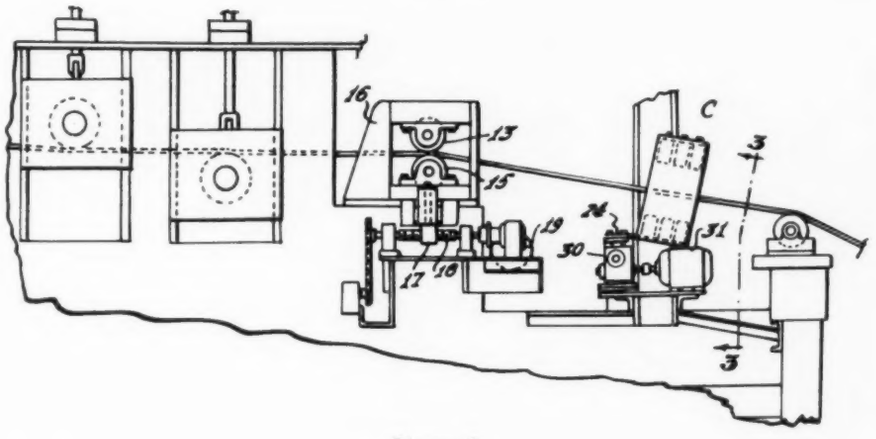


Figure 8

AUTOMATIC STRIP ALINEMENT CONTROL

△ U. S. 2,842,361, issued July 8, 1958 to Harold R. Miller, and assigned to Armco Steel Corp., describes apparatus for maintaining the alinement of a strip of great length which is being processed, together with automatic means of adjusting the sensing devices for different widths of strip.

In Figures 7, 8 and 9, a strip 10 is passing through a processing line. Feed rollers are indicated at 11 and 12; 13 indicates a correcting roll of type which is pivoted at one end at 14 and which at its other end may be moved to the right or left so as to skew the roll 13. The strip, in passing under the roll 13, passes over a roll 15 and the effect of skewing the rolls 13 and 15 is to cause the strip to tend to move in one direction or the other. The rolls 13 and 15 are mounted in a framework which is pivotally mounted at 14 and has at its other end a nut 17 engaging a screw 18, which screw is actuated by a motor 19. A pair of limit switches may be provided as at 20 and 21 to limit the amount of skewing of the rolls 13 and 15.

A control apparatus C is provided adjacent the correcting roll apparatus. It consists of a pair of carriages 22 and 23. The carriages are mounted on brackets 24 and 25 and these brackets carry the nuts 26, 27 and means to engage the rail 28. The nuts 26 and 27 engage threaded portions of the screw 29 so that if

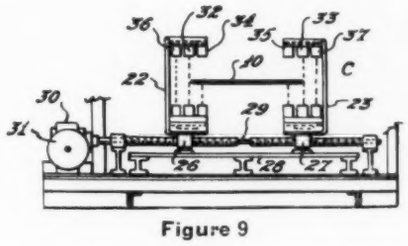


Figure 9

the screw 29 is rotated in one direction, the carriages 22, 23 are caused to approach each other and when the screw 29 is rotated in the opposite direction, the carriages are caused to move apart. The screw 29 is rotated through a gear reducer 30 by means of a motor 31.

Each of the carriages 22 and 23 carries three sensing elements. These sensing elements consist in each case of a light source and a photocell. The six light sources may either be disposed above the strip and the six photocells below, or vice versa. The center sensing elements of each group of three, and indicated at 32 and 33, are positioned adjacent the strip edges and are connected to the motor 19 to cause it to rotate in one

direction or the other when one or the other of the light beams of the sensing elements 32, 33 is interrupted. Thus, the sensing elements 32, 33 control the operation of the motor 19 to maintain alinement of the strip. The inner pair of sensing elements 34 and 35 and the outer pair of sensing elements 36 and 37 are connected to the motor 31 so that if a narrower strip is passing through the line and the light beams of the elements 34, 35 can both pass the edges of the strip 10, the motor 31 will be energized to rotate in such a direction to cause the carriages 22 and 23 to move toward each other to realine the elements 32 and 33 with the strip edges. If a wider strip passes through the line such that the light beams of the elements 36 and 37 are interrupted, the motor 31 is energized to rotate in the opposite direction to cause the carriages 22 and 23 to move apart to bring the elements 32 and 33 back into proper sensing position.

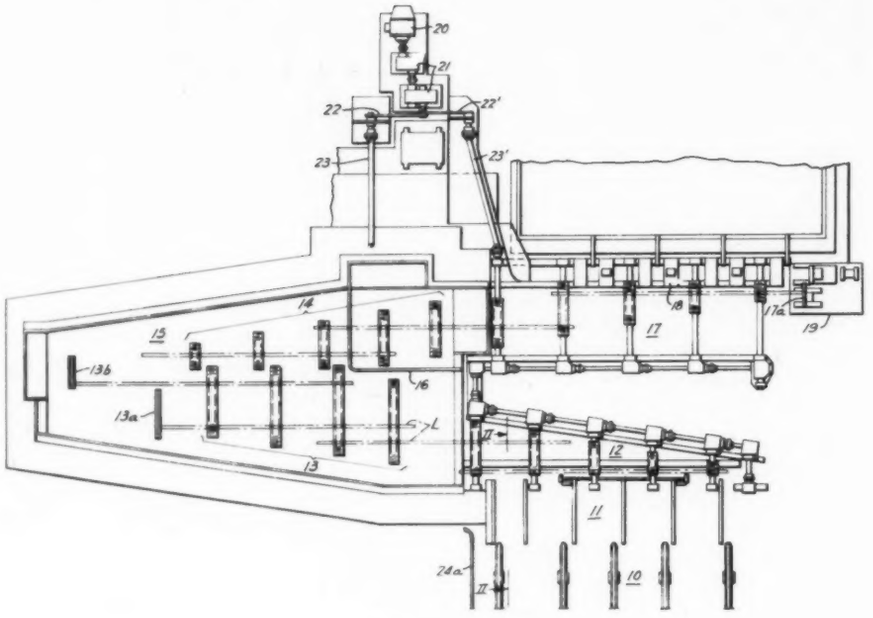


Figure 10

APPARATUS FOR GALVANIZING PIPE

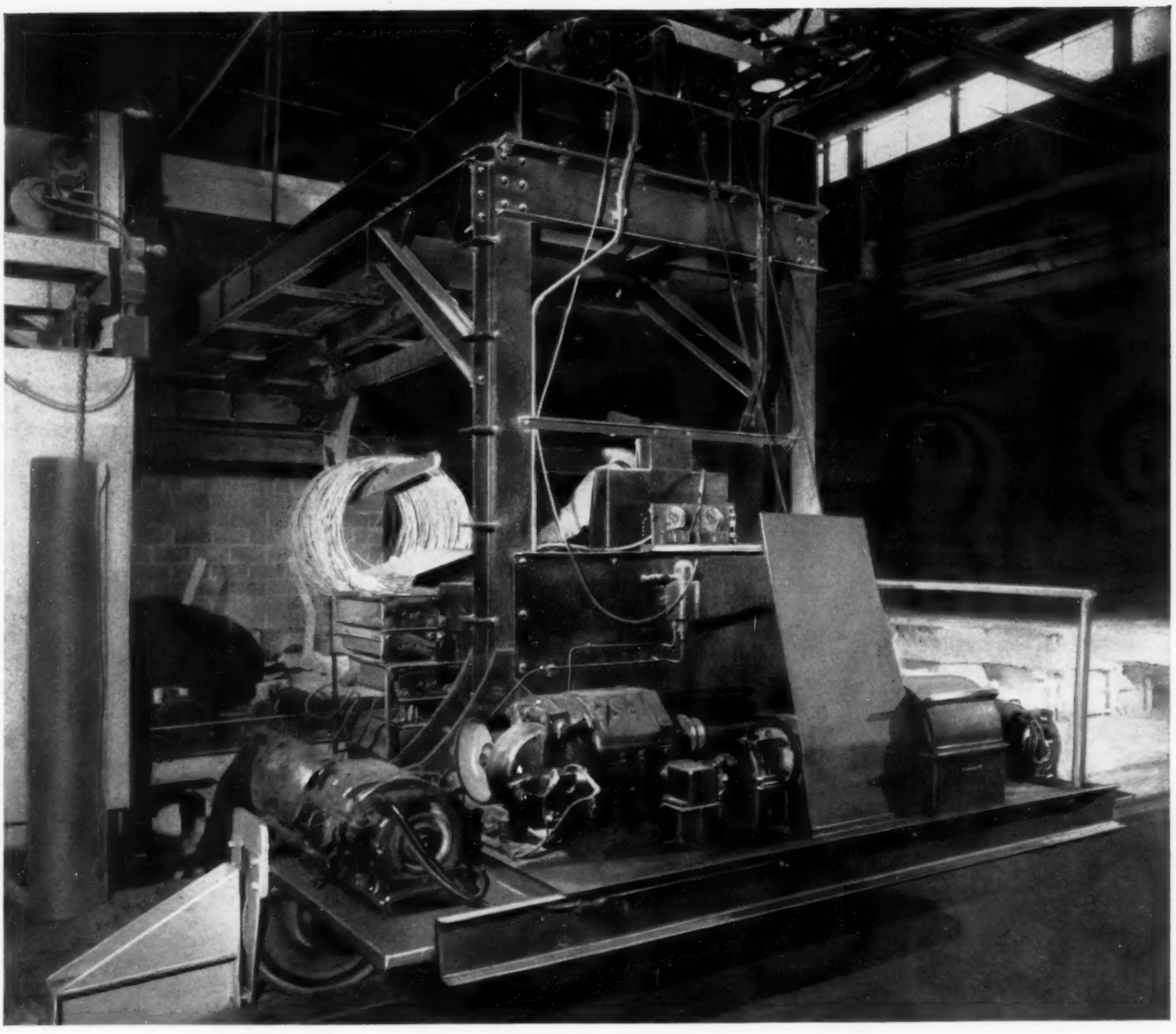
△ U. S. 2,844,122, issued July 22, 1958 to Andrew F. Kritscher, assigned to United States Steel Corp., relates to the coating of pipe with zinc by immersion in molten spelter.

It has been the practice, in the continuous galvanizing of pipe, to introduce successive lengths of pipe endwise into the spelter bath, with the leading end lower than the trailing end, then to lower the trailing end below the surface of the bath and raise the leading end, after which the pipe lengths are removed by endwise movement in the same direction as that in which they were introduced. Apparently, as the leading end enters the bath, the spelter flowing up into the pipe is chilled by contact with it and freezes, forming a zinc plug a short distance from the leading end which, for the moment, prevents the further rise of spelter up through the interior of the pipe. In the meantime, contaminants such as dross and ash floating on the bath enter the trailing end as it is lowered into the bath. Eventually, as the pipe is heated by the bath, the plug at the leading end is melted. By this time a substantial hydrostatic head may exist, tending to force spelter up through the pipe toward the trailing end, but there is no assurance that dross and ash accumulated in the pipe will be flushed out as the pipe length is purged by spelter rising through it. In fact, ash which has already come in contact with the pipe will adhere tightly despite the purging effected by the rising spelter. As a result, the interior of the pipe may not be completely coated with zinc and may have dross adhering to it, which is objectionable.

In the present invention, this difficulty is avoided. The trailing end is not immersed until the pipe has become sufficiently heated to melt the plug at the entry end, thus permitting the pipe to fill with clean molten metal. This precludes the initial entry of dross and ash into the trailing end.

The patent describes apparatus for carrying out the process, which is shown diagrammatically in Figure 10. In general terms, it includes a feed-in table 10, means 11 for delivering pipe lengths singly from it and lowering them onto an entry conveyor 12, sloping downwardly toward the preheating bath. Conveyors 13 and 14 extending down into the bath along an inclined plane, cause progressive immersion of the lengths. A pusher affords positive driving force. Spaced stop plates arrest the entering lengths successively while the conveyors shift the lengths laterally and then withdraw them from the bath through the molten spelter. An exit or discharge conveyor 17 provided with an air-blast pipe receives the emerging lengths and a transfer mechanism 18 places them on a magnetic holding table where they are subject to a blast of steam for removing excess zinc from the interior. The pipe lengths are then ready for shipment, after such finishing treatment or operations as may be desired.

Are you annoyed by having someone borrow your magazine when you want it? Get him to join the AISE.



Boost production 50% with a crane?

This Whiting Gantry Crane did! Designed for a special need, it fits snug quarters, rides neatly under a low ceiling, has its hoisting drive mounted a step above floor level. Busy gantry gets full credit for increasing Continental Steel Company's rod and wire pickling and coating production by more than 50%. It's one of many types of Whiting Engineered Cranes available to meet the special needs of countless operations.

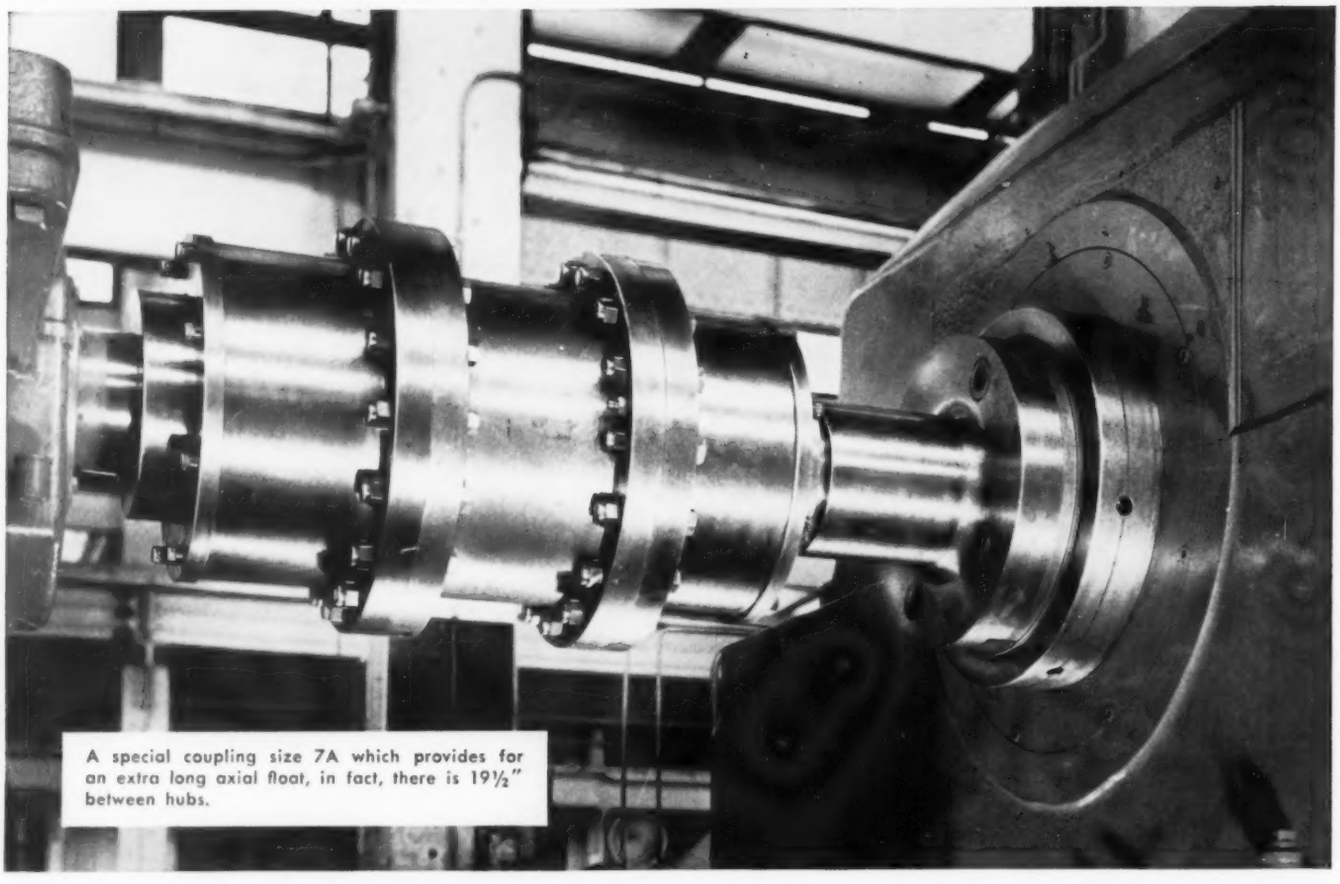
SEND FOR "METALWORKING PROFILES," the big, colorful new booklet of performance reports showing Whiting products on the job . . . bringing new efficiency and economy to the metalworking industries. Remember: what Whiting has done for others can be done for you! *Whiting Corporation, 15655 Lathrop Avenue, Harvey, Illinois.*

87 OF AMERICA'S "FIRST HUNDRED" CORPORATIONS ARE WHITING CUSTOMERS

WHITING CRANES

MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY, RAILROAD AND CHEMICAL PROCESSING EQUIPMENT

SPECIAL COUPLING PROBLEMS



A special coupling size 7A which provides for an extra long axial float, in fact, there is 19½" between hubs.

SOLVED

at JOHN WALDRON

From time to time, manufacturers are faced with special power transmission problems which cannot be handled by standard couplings. Sometimes they need a coupling for exceedingly high speed drives, sometimes a coupling for very large diameter shafts and for other special applications.

John Waldron, which is well known for its ability to produce high quality couplings also makes excellent special couplings to customer requirements. In the past, Waldron has made couplings that turn at speeds over 50,000 RPM, couplings which can take over 45,000 HP and couplings for particular applications such as continuous lubricated couplings, spacer types, shear pins, cut-outs and couplings for many other special installations.

If you have a particular power transmission problem that needs a special coupling, call or write the John Waldron Corporation in New Brunswick, New Jersey. Their long experience in designing, and manufacturing couplings for special problems, may have already solved your problem for you.

MR

JOHN **WALDRON** CORP.

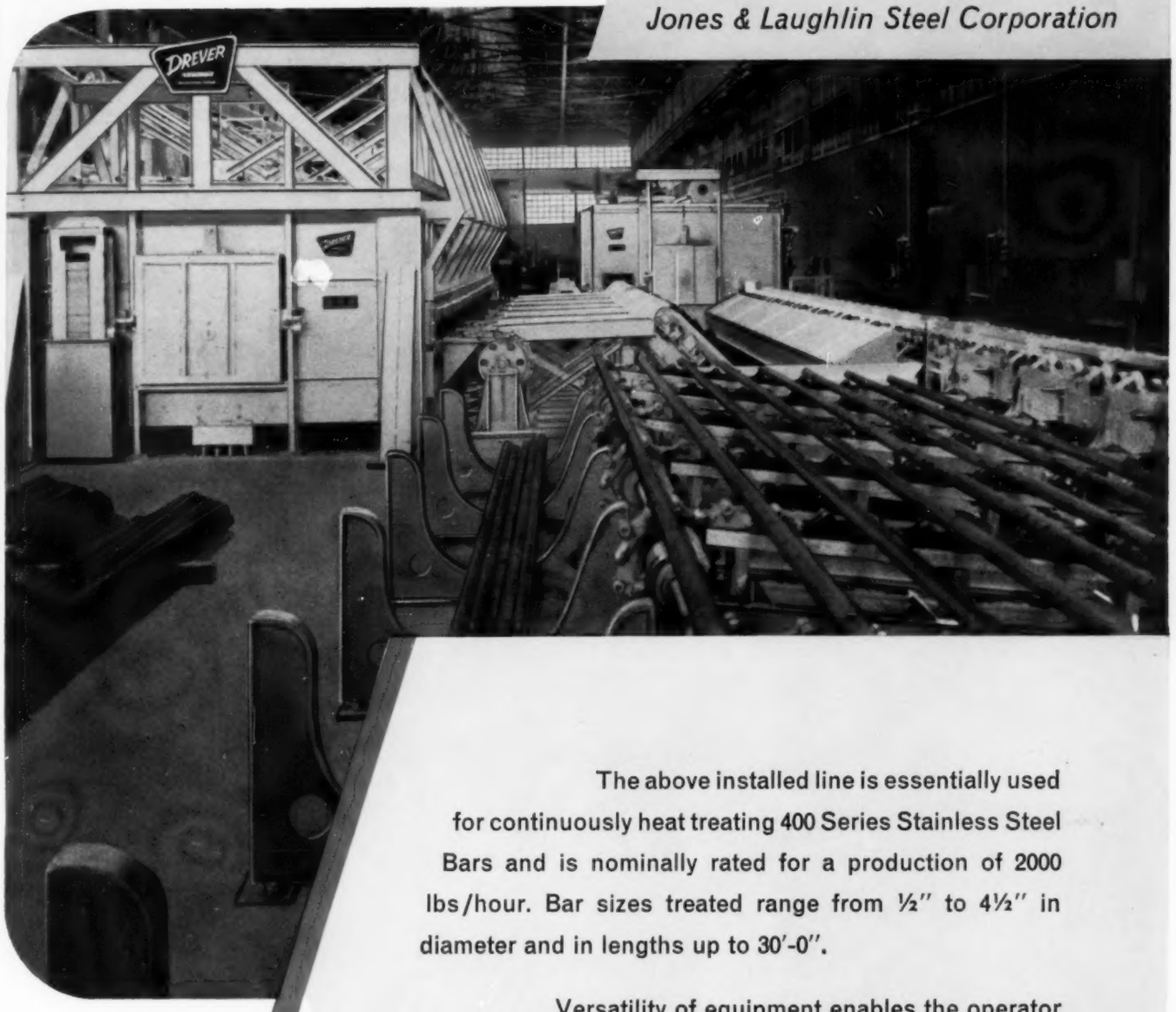
Subsidiary of Midland-Ross Corporation

New Brunswick, New Jersey

DREVER

Continuous BAR HEATING LINE

at the Detroit Plant of the Stainless and Strip Division of Jones & Laughlin Steel Corporation



The above installed line is essentially used for continuously heat treating 400 Series Stainless Steel Bars and is nominally rated for a production of 2000 lbs/hour. Bar sizes treated range from ½" to 4½" in diameter and in lengths up to 30'-0".

Versatility of equipment enables the operator to automatically change from a normalizing cycle to a heat treat cycle, including quench and draw facilities, without the interruption of the continuous operation.

We welcome your inquiry on your wire, rod, bar, sheet, plate and strip heating problems.

DREVER COMPANY

Red Lion Rd. & Philmont Ave.
BETHAYRES, PA.

40

FOR NATIONAL STEEL

KOPPERS BUILDS WORLD'S

Weirton Steel's sintering machine is one of the world's two operating 12-foot wide machines for sintering iron ore. This machine was designed to produce a minimum of 5,500 tons of sinter product per day.

LARGEST SINTERING MACHINES

The two largest iron ore sintering machines in the world—both 12 feet wide—are now in operation. Both are part of plants built by Koppers. Both are helping Divisions of National Steel Corporation improve productivity.

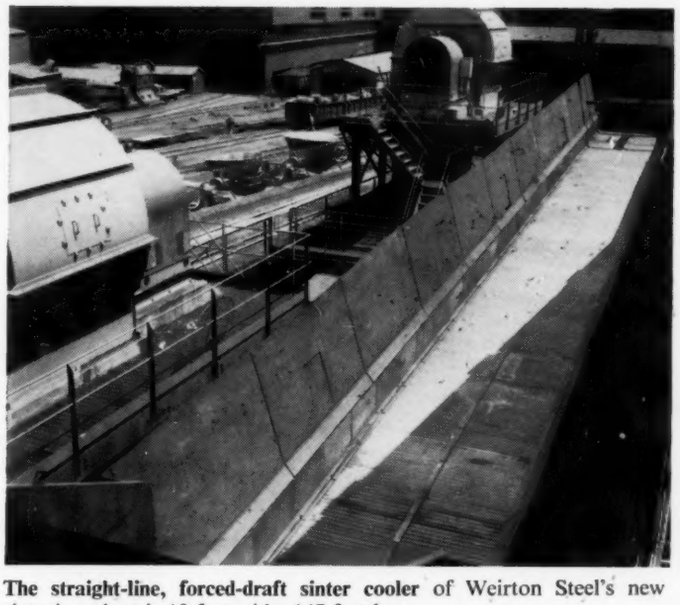
The machine shown here is operating at Weirton Steel Company. It is 12 feet wide, 147 feet long over the wind boxes, has a total grate area of 1,764 sq. ft. It was designed to produce 5,500 tons of sinter product per day.

An even larger machine is also in production at Great Lakes Steel, another Division of National Steel Corporation. This new giant is 12 feet wide and 199 feet 6 inches long over the wind boxes. It was designed to produce 7,200 tons of sinter product per day.

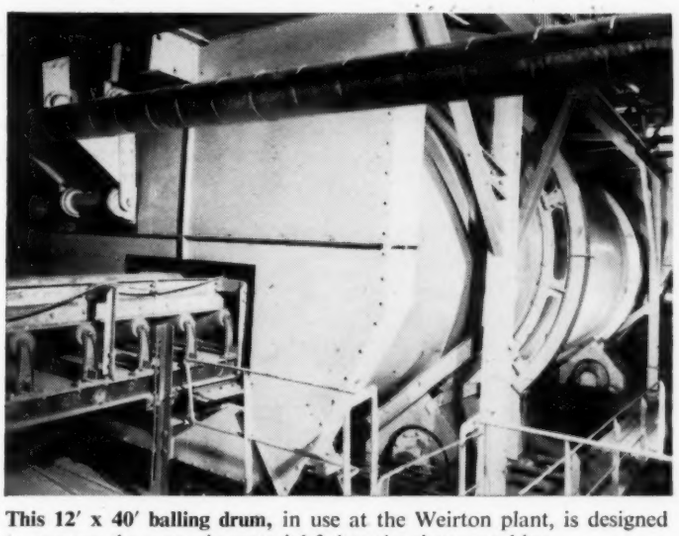
These two pioneering machines are typical of the continual modernization program being carried on throughout the National Steel organization. A forward-looking approach on the part of National Steel's operating and management personnel, and their complete co-operation and assistance during every phase of engineering and construction, contributed greatly to the successful completion of these two projects by Koppers.

Comprehensive Koppers service to the steel industry includes design, engineering, procurement, construction and initial operation of almost any type of equipment.

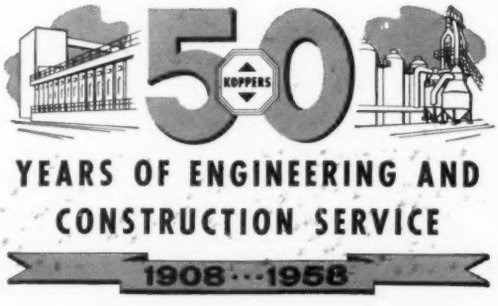
If you need help or advice on any expansion or modernization project, call on Koppers—the world's largest, most experienced, best qualified steel-plant construction firm. Our engineers and management personnel can be reached at Koppers Company, Inc., Engineering and Construction Division, Pittsburgh 19, Pennsylvania.



The straight-line, forced-draft sinter cooler of Weirton Steel's new sintering plant is 10 feet wide, 147 feet long.



This 12′ x 40′ balling drum, in use at the Weirton plant, is designed to prepare the raw mix material fed to the sinter machine.

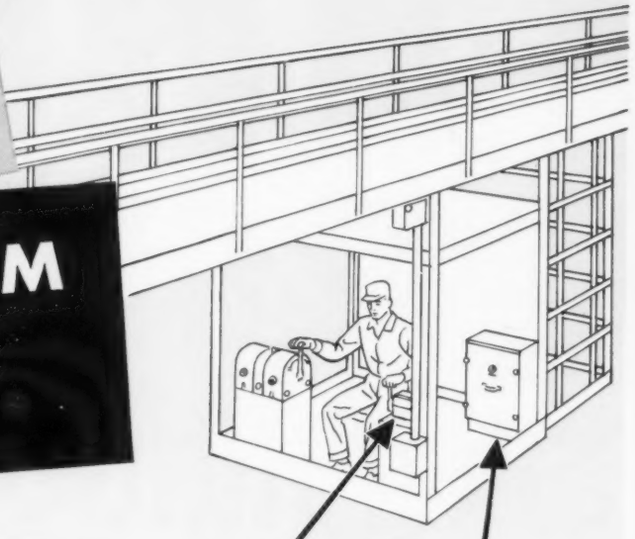


KOPPERS

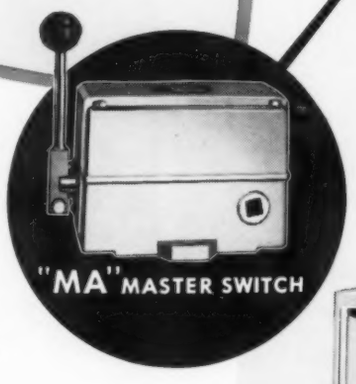
KOPPERS

Better than Manual Control for So Many Reasons!

NEW LOW COST EC&M MAGNETIC CONTROL FOR DC CRANES



Now, on any DC application up to 55 HP, 230 volts, you can have the advantage of full *magnetic* control where manual control formerly was specified purely on the basis of price. At comparable cost, EC&M's new *Type PT* Magnetic Control gives you—



"MA" MASTER SWITCH

Compactness—fits easily in crane cabs, on crane walkways and wherever space is limited.

3-Point Speed Control in either direction.

Reduced Motor Wear through automatic acceleration. Acceleration relays adjustable from 0.2 second up to 3 minutes per step.

Space Saving—front connection permits mounting against wall.

Maximum Safety—completely enclosed.

Fewer Spares—no manual control parts to stock.

Choice of Mounting Arrangements—MA Master Switch can be ganged with other masters or self-contained on top of the PT Controller.

Standardized Overload Protection is available. Separate panel for protection of 1 to 4 motors is smaller, simpler than protective panels used with manual controllers.

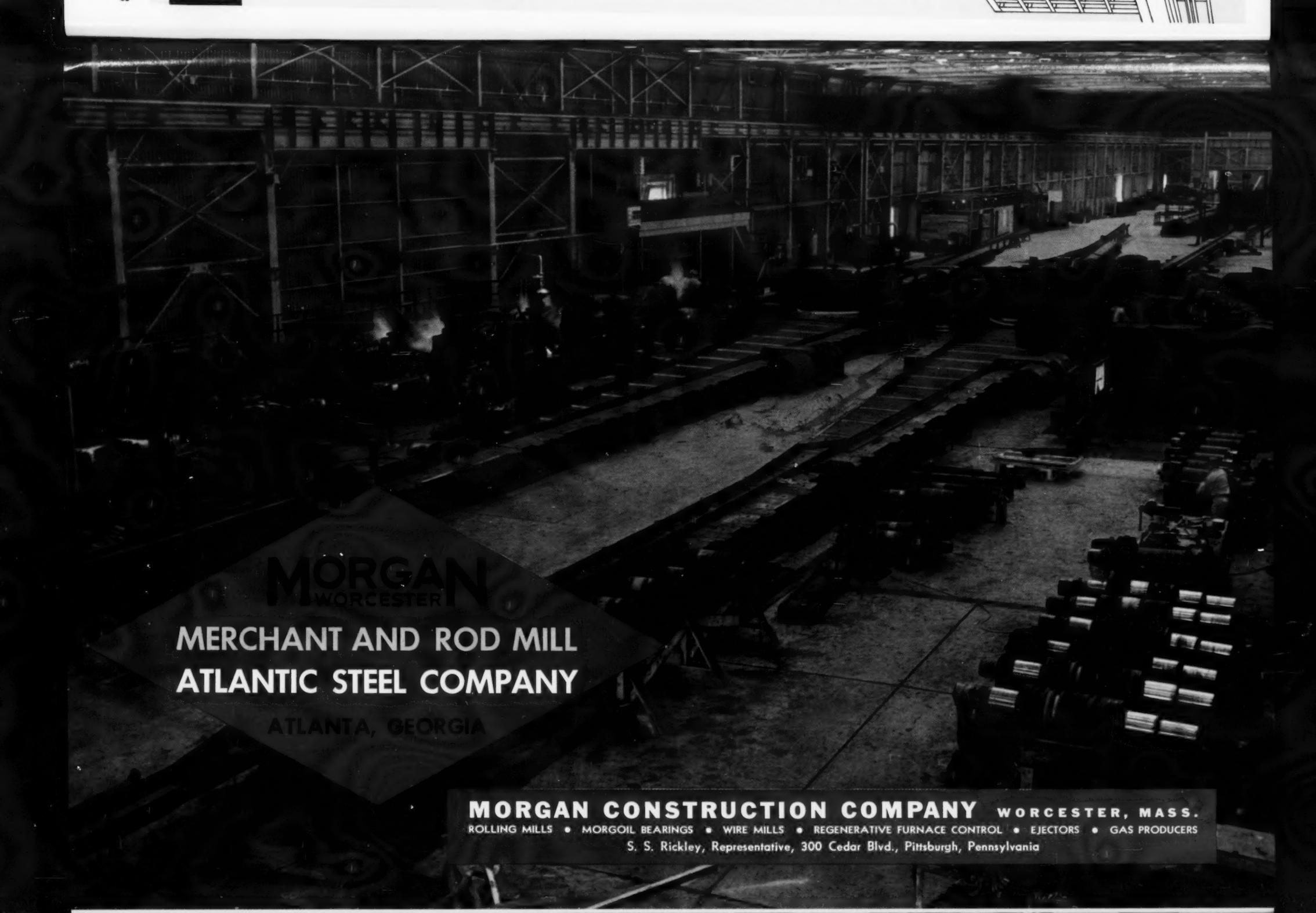
Write FOR BULLETIN 6131

"PT" CONTROLLER
with front cover removed

Available for Hoist, Bridge and Trolley motions on cab or floor-operated cranes

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

1236



MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

ROLLING MILLS • MORGOIL BEARINGS • WIRE MILLS • REGENERATIVE FURNACE CONTROL • EJECTORS • GAS PRODUCERS

S. S. Rickley, Representative, 300 Cedar Blvd., Pittsburgh, Pennsylvania

When you select a Wagner Wagner Transformer...

YOU GET THE TYPE BEST SUITED FOR YOUR PLANT ELECTRICAL SYSTEM...

PLUS... the assurance of continuous, dependable service!

If you are planning a new plant distribution system... modernizing your present one... or adding to its capacity to meet increasing demands for power... it will pay you to specify Wagner Transformers.

For your main plant substation, Wagner Liquid Filled Industrial Power Transformers are available in standardized ratings through 10,000 kva.

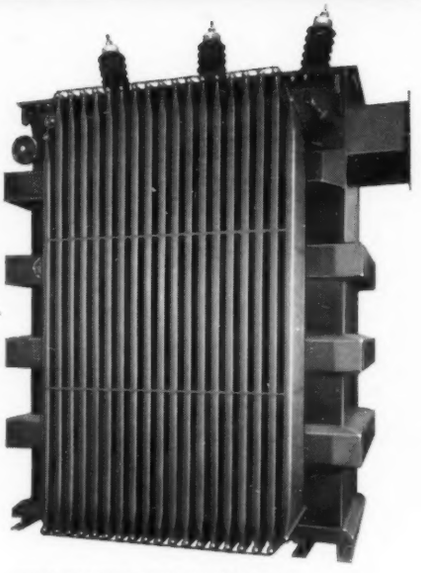
For your load centers, Wagner can supply Unit Substation Transformers in any of the types shown below, furnished with suitable incoming line sections, to meet your particular requirements. These PRE-DESIGNED transformers will save you time and save you job engineering costs. You can specify the secondary switchgear you prefer.

All Wagner Industrial Transformers are liberally designed, sturdily constructed, thoroughly tested and able to meet the heaviest industrial demands. They assure continuous dependable power for years to come.

For expert advice on your present and future plant transformer needs, call or write the Wagner branch near you.

Wagner Electric Corporation
6483 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

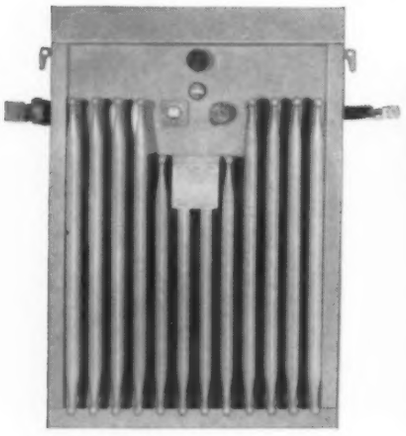


WAGNER INDUSTRIAL POWER TRANSFORMERS

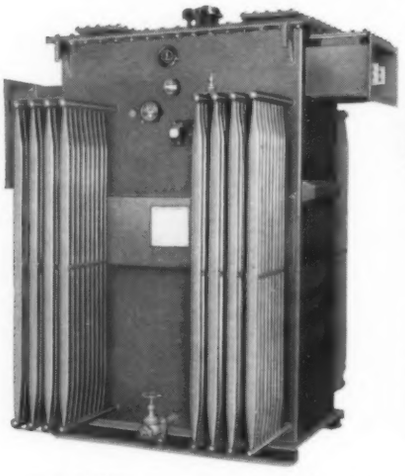
Oil-filled, for outdoor installation, available through 10,000 kva, 67 KV and below. Noflamol filled, for explosive atmospheres, available through 7,500 kva, 15 KV and below.

Wagner **UNIT SUBSTATION TRANSFORMERS**

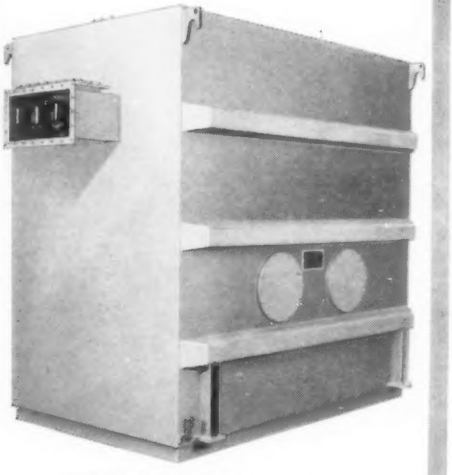
112½ to 2000 Kva—three phase, 60 cycles, 15 KV and below



NOFLAMOL Non-inflammable liquid-filled. For indoor or outdoor installation, where explosive liquids or gases are present. The close-coupled design illustrated fits flush against switchgear enclosures. Throat connected designs are also available. 55°C rise, self-cooled or forced-air cooled.

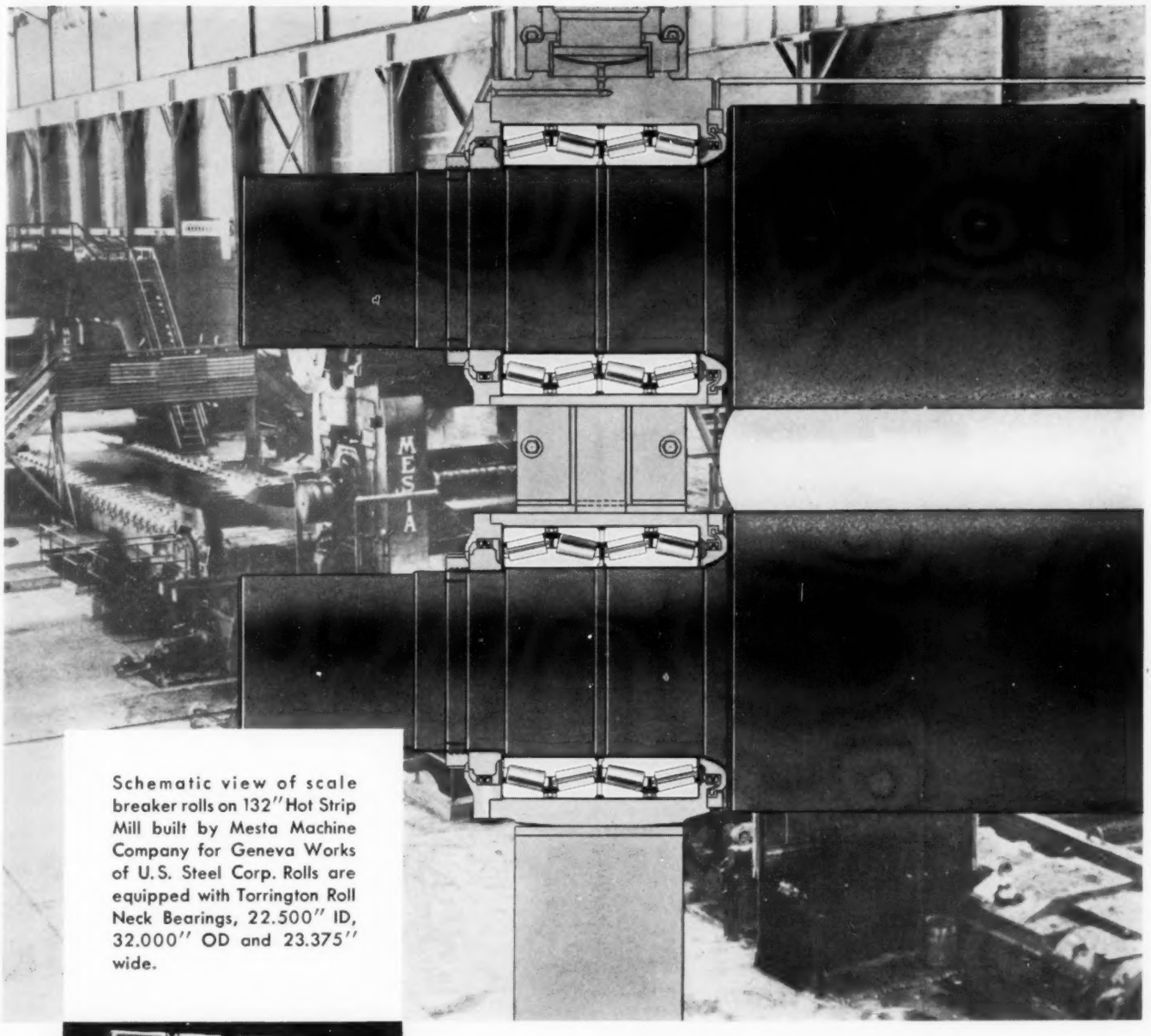


OIL-FILLED Generally installed outdoors. Can be used indoors in fireproof vaults. Outdoor transformers can be connected to indoor switchgear using weather-proof bus-duct. 55°C rise, self-cooled or forced-air cooled.

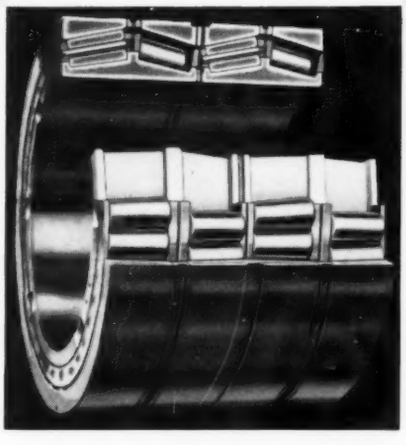


SEALED DRY-TYPE Suitable for indoor or outdoor use, completely fireproof, easy to clean and maintain. Sealed tank is filled with nitrogen under low pressure. Insulated for 150°C rise, self-cooled.

WTSB-16A.



Schematic view of scale breaker rolls on 132" Hot Strip Mill built by Mesta Machine Company for Geneva Works of U.S. Steel Corp. Rolls are equipped with Torrington Roll Neck Bearings, 22.500" ID, 32.000" OD and 23.375" wide.



Torrington Roll Neck Bearings give maximum capacity with minimum cross section

Torrington Four-Row Tapered Roller Bearings take heavy radial and thrust loads in stride on the roll necks of two-high scale breaker at the Geneva Works of U.S. Steel Corp.

These bearings are made of finest quality electric furnace steel, toughened and case-hardened through seven heat-treating cycles. This enables Torrington Engineers to design the bearing geometry within a minimum cross section. Maximum load capacity and higher roll neck strength are obtained.

You will find that Torrington Roll Neck Bearings pay off in higher tonnage, reduced maintenance and down time. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

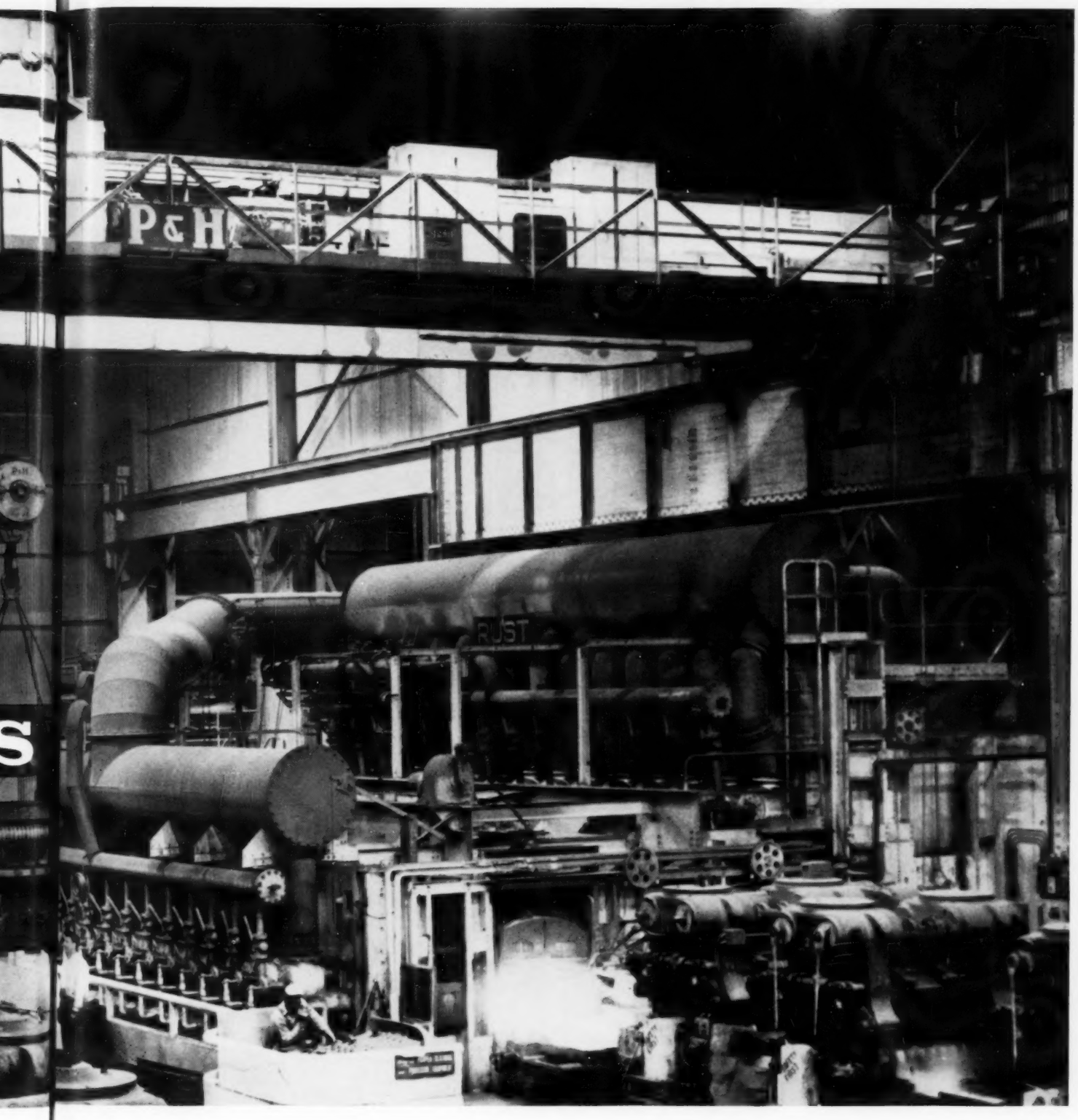
TAPERED ROLLER • SPHERICAL ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

Speed steel production with faster duty cycles!

It's easier to keep production moving with P&H overhead cranes. They have the power and smooth control that enable operators to spot giant loads quickly and safely. Their electrical and structural parts exceed mill standards — withstand the extremely severe duty cycles found in mill service.

You can rely on P&H research for new developments to increase crane efficiency. The latest, P&H Electronic "Stepless" Control, makes fixed-speed steps obsolete — provides an AC crane with better speed selection than DC control.

The new control furnishes the right speed for

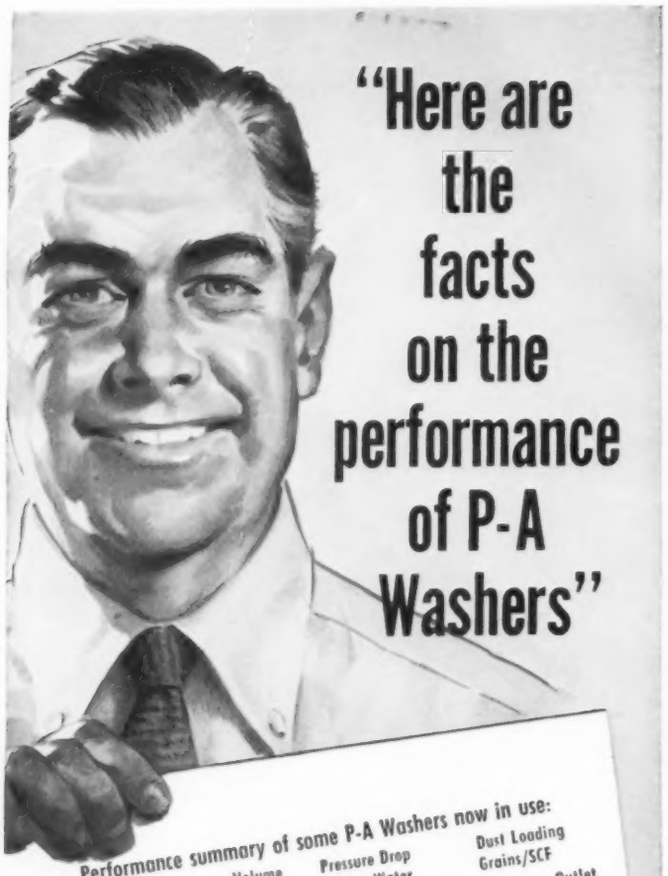


each crane operation — eliminates load sway and jerky "inching." "Stepless" control permits faster, smoother handling and precision spotting of materials for quicker servicing of heavy equipment or movement of material. It has a simple wiring circuit that eliminates 58 contacts, thus slashing crane maintenance and parts inventory.

Find out how you can speed duty cycles and lower costs with P&H overhead cranes. Write Dept. 105G, Harnischfeger Corp., Milwaukee 46, Wis.

HARNISCHFEGER

P&H ... quality and service for 74 years



"Here are the facts on the performance of P-A Washers"

Performance summary of some P-A Washers now in use:

Installation	Years Operated	Volume SCFM	Pressure Drop Inches Water	Dust Loading Grains/SCF Inlet	Outlet
A	4	78,000	30	3-19.0	.01-.04
B	3½	78,000	30	2-3	.02-.08
C	3	85,000	30-40	2-3	.01-.03
D	3	45,000	30	2	.02-.03
E	½	75,000	50	—	.02
F*	½	26,000	12	5	.10
G*	½	26,000	12	5	.10
H	½	90,000	29	—	.04

*Two units in parallel on one furnace. Lower efficiency due to lower available top pressure

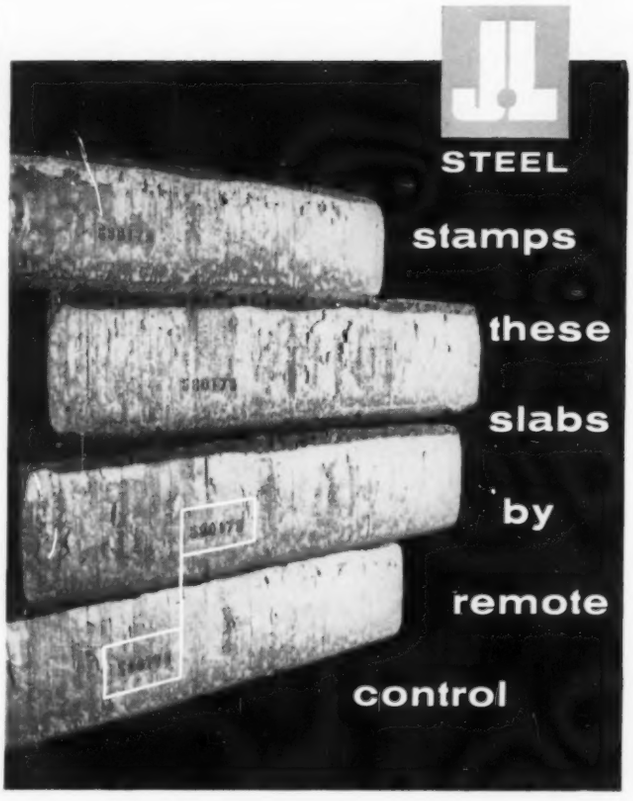
These actual performance figures reflect the highly efficient operation of the Pease-Anthony washer. This venturi scrubber puts your full top pressure to work cleaning the gas. No secondary cleaner required for most installations. Present users report no maintenance problems. If you have a blast furnace scheduled for construction or rebuilding, plan now for P-A Venturi installation. Capacities up to 150,000 SCFM. Write for bulletin M-103.

CHEMICO

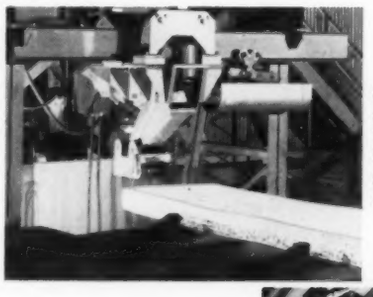
P-A GAS SCRUBBERS

CHEMICAL CONSTRUCTION CORPORATION

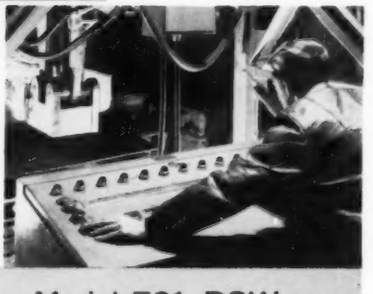
525 West 43rd Street, New York 36, New York
Telephone LOngacre 4-9400
Technical Representatives Throughout The World
Cable Address: CHEMICONST, N. Y.



Deep, clear-cut, even impressions in slabs and blooms—*it's being done by remote control* at the 44" Blooming Mill in Jones & Laughlin's Aliquippa Works. This machine does the job better, faster, more economically, more safely than hand methods previously used. *Write for new bulletin on Remote-Control Marking.*



Slab in position for stamping with pneumatically-powered marking head. Both blooms and slabs are marked by the machine at J & L.



Any of the nine numbers in the marking head may be changed by pressing buttons on this control panel. A single button also actuates the stamping cycle.

Mecco SAFETY MARKING TOOLS

Model 701-RCW

SLAB MARKER

A Product of the Marking Device Industry

M. E. CUNNINGHAM CO.

1041 CHATEAU STREET, PITTSBURGH 33, PA.

Only APPLETON has the capacity to provide you with ALL the *Unilets* you need regardless of size, type arrangement or design . . . Special U.L. Approved explosion-proof, dust-tight and weather-tight models for industrial areas! Malleable iron construction for greater safety! Special features for fast, easy maintenance work, re-wiring, etc. Large stocks in all sizes for quick availability! Yes, whatever the need, your best source of supply is APPLETON for *Unilets.*

WHY SHOP AROUND?

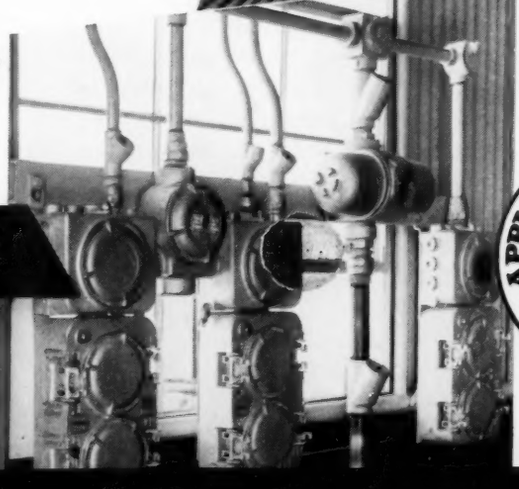
As the illustrations on this page suggest, you can get practically anything needed for wiring or lighting in hazardous or non-hazardous areas from APPLETON. There is no need to "split" orders. Next time you buy, consult APPLETON . . . full information on request.

Control panel showing APPLETON *Unilets* in a wide range of styles and sizes in use at main line gas booster station

APPLETON® UNILETS* for every purse

Hazardous area lighting with APPLETON explosion-proof "EFU" type *Unilet* fluorescent lights. All fixtures, hangers, brackets and swivels are APPLETON-designed and built

Hundreds of APPLETON *Unilets* can be seen in this typical generator plant cable room



Display panel board showing close-up view of several types of explosion-proof, weather-tight *Unilets* frequently found in oil refineries, chemical plants, steel mills and many other industrial areas

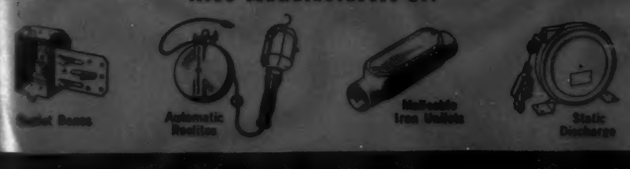
**Only APPLETON Makes Unilets*

Sold Through Franchised Distributors Only

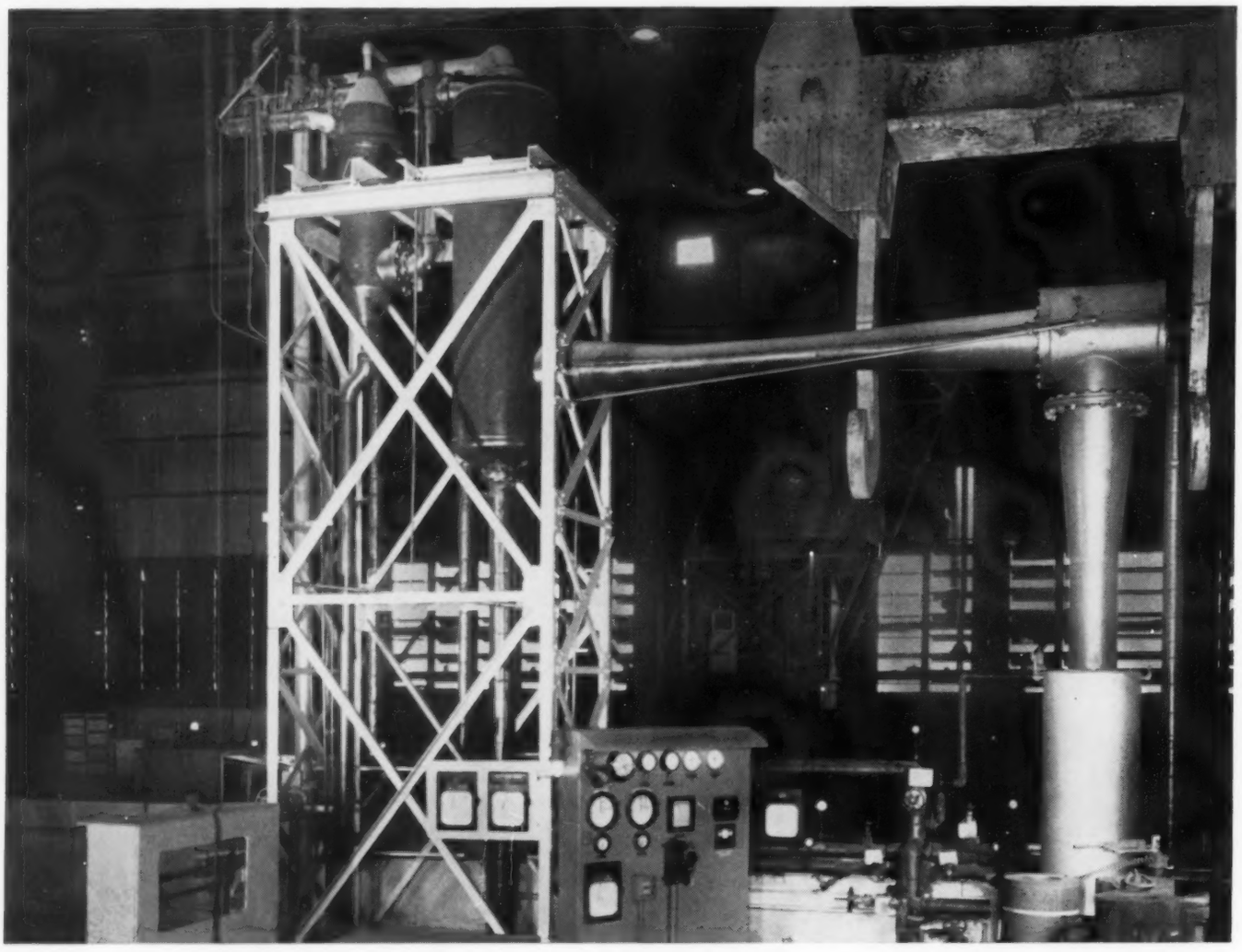
APPLETON ELECTRIC - PRODUCTS®

APPLETON ELECTRIC COMPANY
1701 Wellington, Chicago 13, Ill.

Also Manufacturers of:



In this 36-in. four-stage Elliott steam jet ejector, the first stage at lower right points vertically upward, second stage in center points horizontally to the left. Third and fourth stages are at upper left, instrument panel is on lower center.



today **ALL** production-size vacuum casting operations employ **ELLIOTT EJECTORS**

THE BIG BREAK-THROUGH in the degassing of steel is made possible by Elliott multistage steam jet ejectors. While high-grade steel forging ingots (up to 250 tons) are being poured, Elliott ejectors are removing unwanted gases, efficiently and economically. Results are stronger, more uniform forgings, improved ductility, and reduced flaking and embrittlement.

Elliott steam jet ejectors are currently in use or on order for *all of the vacuum casting installations of production size* throughout the country. One example of several applications already in operation is the United States Steel Corporation installation seen above, a 36-in. four-stage steam jet pumping unit. Others include a 24-in. six-stage steam jet ejector which serves a consumable electrode vacuum melting furnace, a 36-in. six-stage ejector serving a vacuum heat treating furnace, and two five-stage ejectors serving vacuum induction melting furnaces.

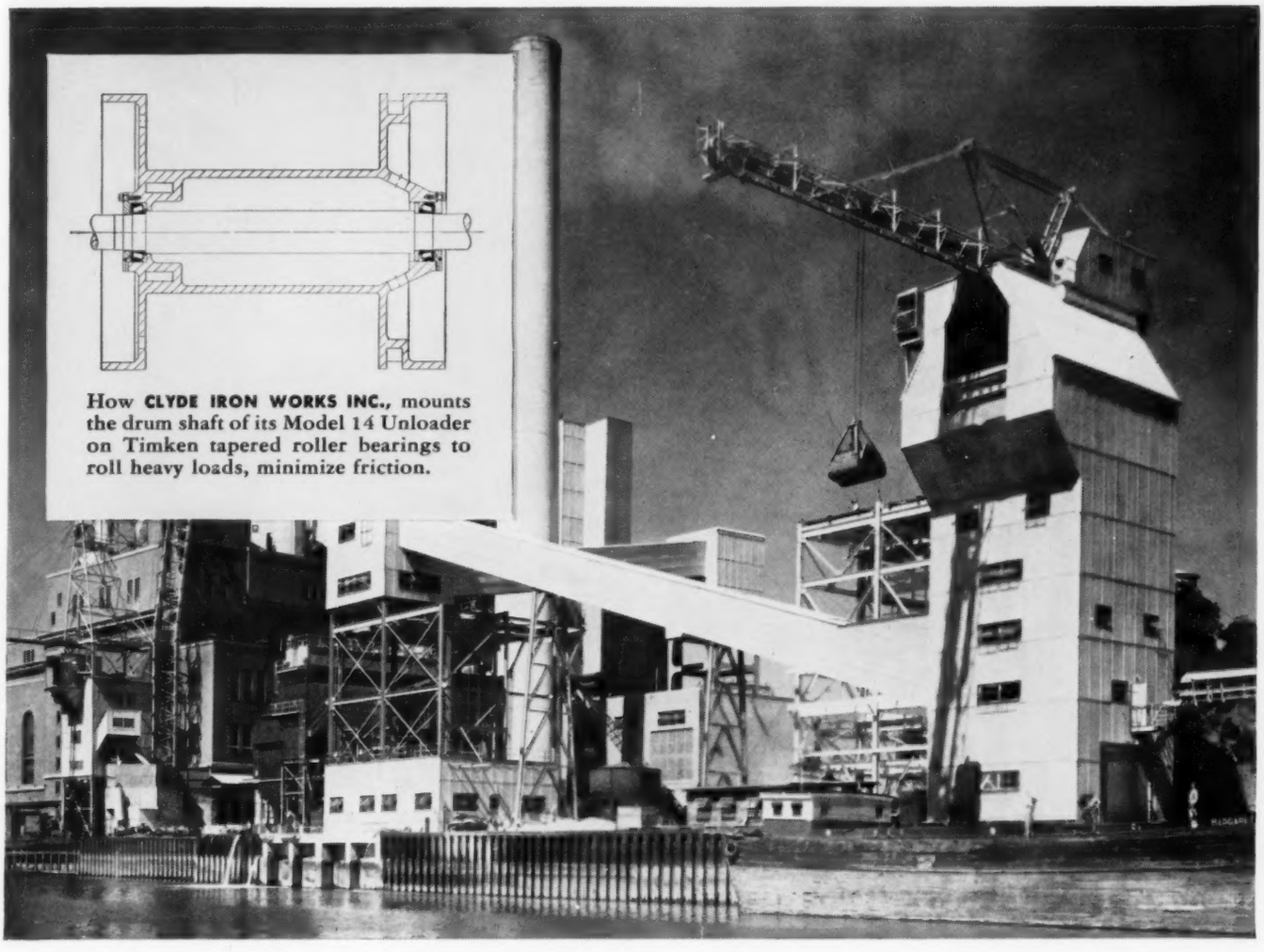
Elliott Steam Jet Ejectors provide these advantages:

SIMPLICITY • ECONOMY

COMPACTNESS • DEPENDABILITY

ELLIOTT Company
JEANNETTE, PA.

G9-2



How **CLYDE IRON WORKS INC.**, mounts the drum shaft of its Model 14 Unloader on Timken tapered roller bearings to roll heavy loads, minimize friction.

Clyde Unloader unloads 250 T.P.H. as 22 Timken® bearings roll the loads

UNLOADING coal barges at a 250 ton-per-hour rate puts terrific loads on the hoist drums and sheaves of the Clyde Model 14 Unloader. To roll the heavy loads steadily and smoothly, Clyde engineers mount the three drums and eight sheaves on a total of 22 Timken® tapered roller bearings.

Timken bearings have *extra* load-carrying capacity. That's because of full-line contact between their rollers and races. And the tapered construction of Timken bearings lets them take both radial and thrust loads in any combination. Because they're geometrically designed and precision-manufactured to roll true, Timken bearings practically eliminate friction. They reduce power loss, last longer; keep the drums and sheaves working smoother, steadier, with less maintenance.

To get all these advantages when you buy or build machines, specify Timken tapered roller bearings. Look for the "Timken Bearing Equipped" label. It's your symbol of Better-ness. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

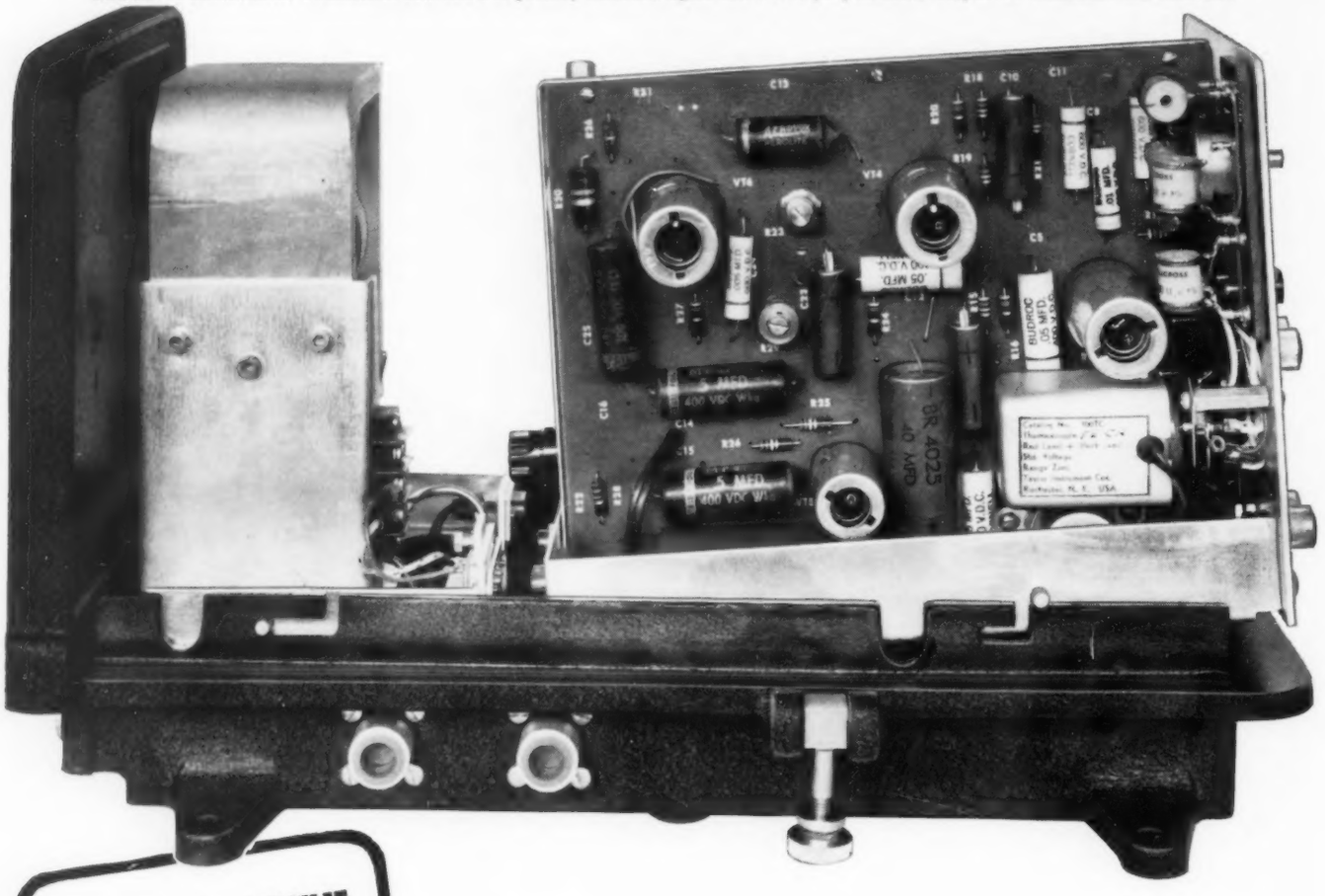
This symbol on a product means its bearings are the best.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD

TRANSET* Potentiometer Transmitter converts a dc primary electrical signal into a 3-15 psi pneumatic output for controllers and receivers.

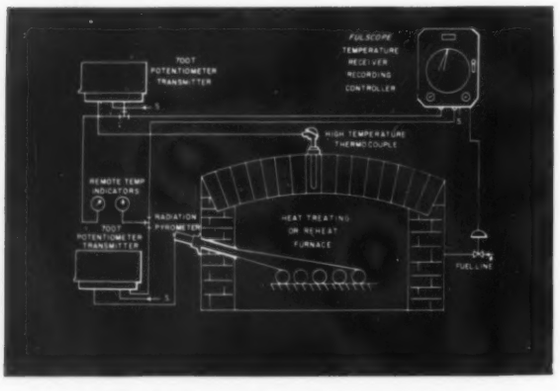


IMMEDIATE DELIVERY

Taylor Potentiometer Transmitters

Calibrated to your "specs". The unique plug-in features of this instrument—plug-in transducer, plug-in service "cans"—mean that it can be custom-equipped for your specific application. They also mean that we can fill your order immediately from stock.

These same features permit you, with minimum inventory of components, to keep your instruments in continuous service or to adapt them to different processing conditions.



Taylor TRANSET Potentiometer Transmitters applied to a Heat Treating Furnace.

Plug-In service "cans" means that the instrument can be quickly adapted for use with different primary elements by simply plugging in the corresponding can. (For thermocouple applications cold junction compensation is provided in the can.)

Just one amplifier. You change its service by switching service cans. Both the amplifier and the transducer plug-in . . . means minimum instrument down-time for service. Also means low instrument inventory because you only need one spare amplifier.

Call your Taylor Field Engineer, or write for **Catalog 98262.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ontario.

INSTRUMENTS IN STOCK FOR USE WITH THESE PRIMARY ELEMENTS

THERMOCOUPLES . . . Copper-Constantan . . . Iron-Constantan . . . Chromel-Alumel

VOLTAGE . . . For pH; strain gages; tachometers; or any millivolt span from 3 to 50 mv.

*Reg. U.S. Pat. Off.

Taylor Instruments MEAN ACCURACY FIRST

Tight space? Perfect place for a Link-Belt Gearmotor

Maintains life-long alignment with flange-mounted NEMA motors

Here's a speed reducer right in step with industry's campaign for higher productivity in less space. Because its gear trains incorporate a minimum of parts . . . because its motor is directly connected to the gear drive with a flange—the Link-Belt Gearmotor is the ultimate in compactness.

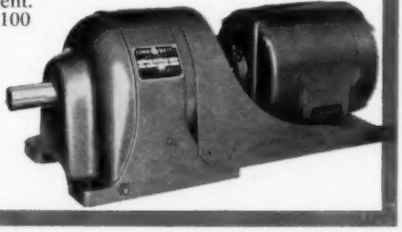
Imagine how these same features cut costs. The flange connection eliminates additional coupling devices. Simple gear trains have fewer parts to wear, to service, to invite trouble.

You'll find them in Book 2447. Call your authorized Link-Belt stock-carrying distributor or nearby Link-Belt office.

LINK-BELT

SPEED REDUCERS

LINK-BELT MOTOGEAR—for bracket-mounting all makes and enclosures of foot-type NEMA motors — simplifies motor replacement. Sizes to 100 hp.



LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.806

The pit nobody liked...

except our customers

This is of course our one-way fired soaking pit . . . fired from the top.

The location of the burner is only one of the features responsible for its enthusiastic acceptance. Most important however are the 30 years of experience and refinements which we have built into the pit since we first introduced it.

That is why, today, it is the pit everybody respects . . . especially our customers.

STEEL MILL, HEAT TREAT, GLASS DIVISIONS

SURFACE COMBUSTION CORPORATION

2404 DORR ST., TOLEDO 1, OHIO

wherever heat is used in industry

Associated Companies: British Furnaces, Ltd., Chesterfield • Stein & Atkinson, Ltd., London • Stein & Roubaix, Paris • S. A. Belge, Stein & Roubaix, Bressoux, Liege • S. A. Forni Stein, Genoa • Chugai Ro Kogyo Kaisha, Ltd., Osaka •

Surface®

KAISER ENGINEERS

—has designed and built,

—is designing and building,

—will design and build...

Air pollution control and water treatment

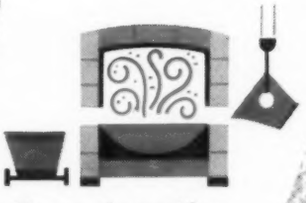
By-products plants

Ore beneficiation and handling

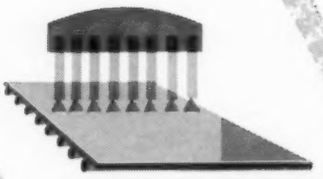
L-D Process plants

Blast furnaces

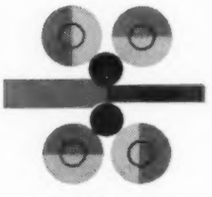
Pipe mills



Open hearths



Sinter plants



Rolling mills

Kaiser Engineers designs and builds every part of a steel mill. Been doing it for years. KE has the experience, and the ingenuity, to develop time-cutting, cost-saving new ways to build and operate. The result is a better plant, sooner, for less.

Experience, ingenuity—and a cost-conscious approach. This is what KE can apply to your steel plant expansion program right now. Call or write—today.

Pittsburgh, 330 Grant St., AT 1-7992
New York, 300 Park Ave., PL 9-1100
Oakland, 1924 Broadway, CR 1-2211

KAISER ENGINEERS

KAISER ENGINEERS engineers-contractors
Contracting since 1914

Division of Henry J. Kaiser Company · Oakland 12, California · New York, Pittsburgh, Washington, D. C., Buenos Aires, Calcutta, Dusseldorf, Montreal, Rio de Janeiro, Sydney, Tokyo

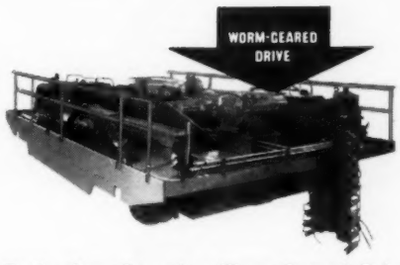
Crane control so exact you can polish your car

Polishing a $5,000 Mercedes-Benz with a cloth wrapped around a crane hook takes perfect control. Foolish idea? Not really. The hot and cold steel you handle and the equipment nearby are worth many times the cost of a quality car. That's why the total control provided by Shaw-Box is so vitally important to mills.

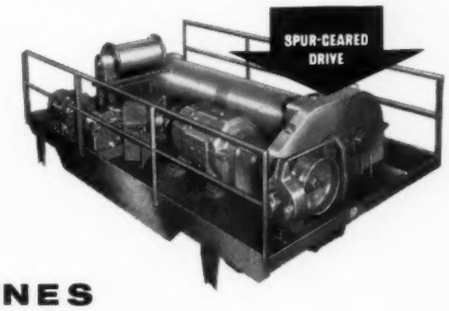
Shaw-Box Builds Cranes to AISE Specs or Your Own

You name the crane — any type, any size — Shaw-Box has the design and engineering experience and the facilities to meet AISE or your own specifications. You get total crane control that means everything in precision operation — everything in safety for man, load and crane. You can be sure of low maintenance and low power consumption. We assure complete dependability and highest performance regardless of service conditions.

Call in one of our engineers. He will gladly discuss specifications and tell you about our standard AISE designs for 5 to 500-ton cranes. Your inquiry is invited.



Prefer Spur-Geared or Worm-Geared Drive? Shaw-Box can meet AISE or your requirements exactly, whichever type is best for your application.



58K-2

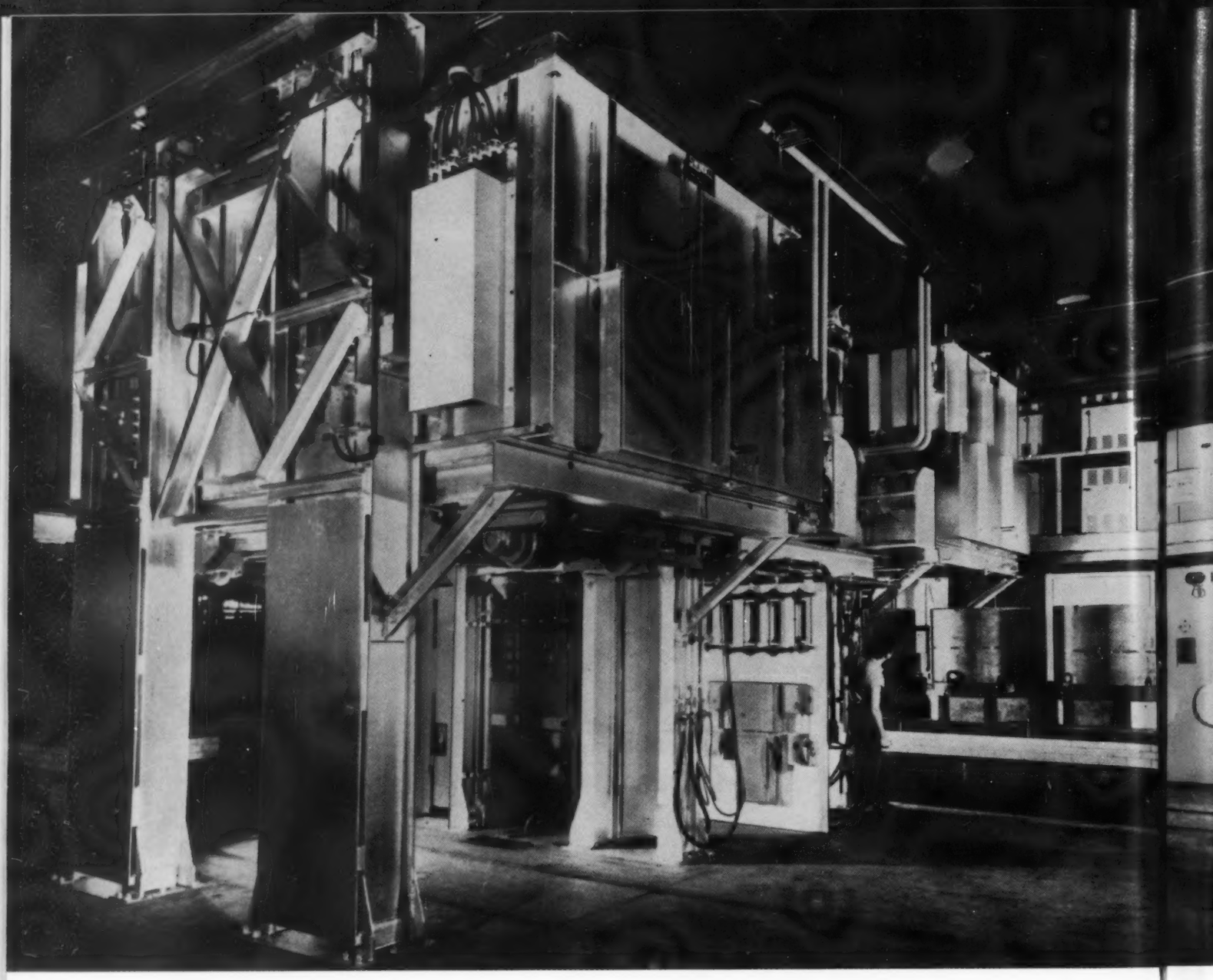
MAXWELL MANNING & MOORE INC. TRADE MARK

"Shaw-Box"® CRANES

MANNING, MAXWELL & MOORE, INC.
SHAW-BOX CRANE & HOIST DIVISION
388 W. Broadway • Muskegon, Michigan

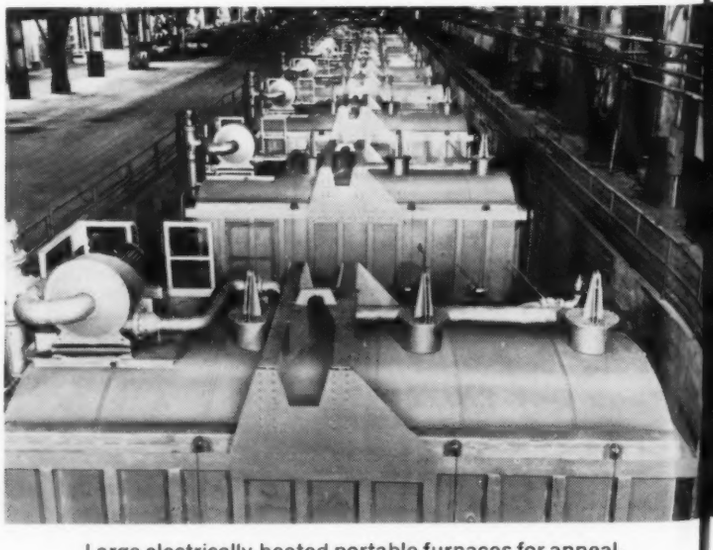
Builders of "SHAW-BOX" and LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Other Divisions produce 'ASHCROFT' Gauges 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, and 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments.

In Canada: ***Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario***



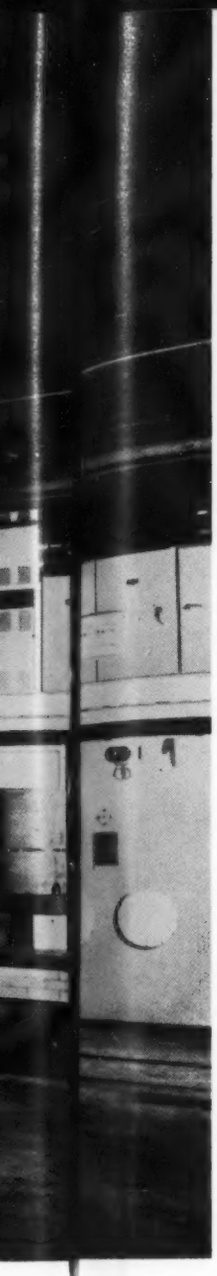
Electrically-heated elevator furnaces for atmosphere annealing at temperatures in the range of 2000° Fahrenheit.

SWINDELL-DRESSLER



Large electrically-heated portable furnaces for annealing electrical steels in recirculating protective atmospheres at high temperatures.

ENGINEERING SERVICE Swindell-Dressler Corporation provides a complete engineering service for the steel industry in the design and construction of new plants, and modernization of existing facilities. Consultations arranged gladly on request.



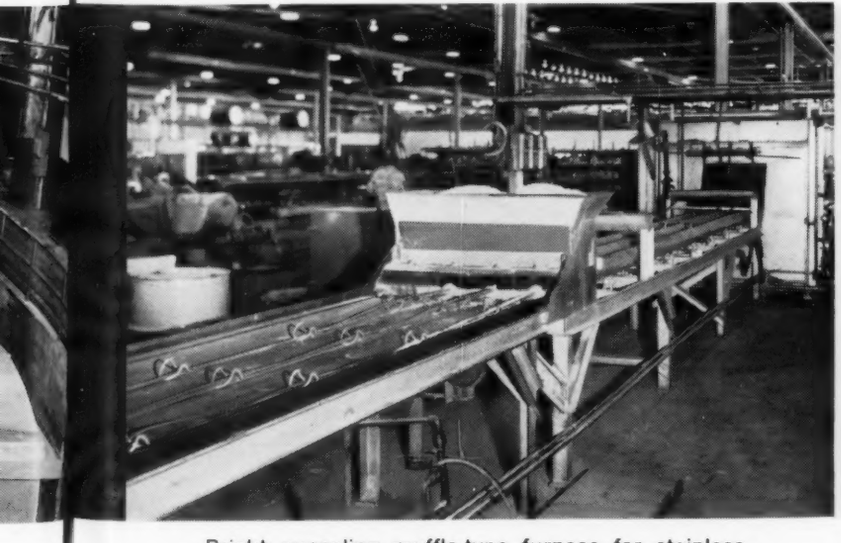
When your requirements are for

HIGH-VOLUME HIGH-TEMPERATURE Annealing

Let SWINDELL-DRESSLER serve!

The elevated-temperature annealing of cut products and small coils is a Swindell-Dressler specialty. Employing advanced design and construction features for high production rates, our range of furnace types and capacities covers every high temperature annealing requirement—including those for special steels, and titanium. Let us go into the details with you, at your convenience.

FURNACES for sheet and strip annealing



Bright annealing muffle-type furnace for stainless tubes. Product is drawn through muffle containing protective atmosphere of hydrogen.

SWINDELL-DRESSLER CORPORATION

DESIGNERS AND BUILDERS
OF MODERN INDUSTRIAL FURNACES

PITTSBURGH 30, PA.

Q: Where would you look for *Air Products* in this picture?

A: Almost anywhere, in a steel mill.

(Aside from providing the best supply systems for oxygen and other gases, Air Products contributes to steelmaking technology as well.)

Air Products Applications Engineers may be found anywhere in a steel mill. They're hard to pick out because they look like—and are—steel men themselves.

- You may find them in the blast furnace area. *Air Products* oxygen has been used to enrich blast furnaces for over seven years.
- And you'll find them on the open hearth floor, helping to get more tons per hour from furnaces, through startling new practices. They started working with combustion oxygen in 1945 and with roof jets in their earliest stages of development. Current advances in this area at mills served by *Air Products* are helping to raise industry standards on almost a monthly basis.
- If it's an oxygen converter shop, odds are better than even that you'll find *Air Products* there. Many of their innovations have contributed to the growth of converter progress.

Although *Air Products* has changed oxygen from a costly specialty to a basic utility, the story doesn't end there. *Air Products* "steel men" are on the job around the clock . . . to help you increase production and make better iron and steel at less cost.

for open hearth oxygen applications
for all oxygen converter processes
for blast furnace oxygen enrichment
for desiliconization of iron
for lance decarbonization

to find how Air Products can work for you, write, wire or call today.

Air Products
...INCORPORATED
Allentown, Penna.

For Fast, Efficient, *Low-Cost* Pickling

Install a WELDCO Mechanical Tube Pickler As Youngstown Sheet & Tube did at *Indiana Harbor*

Four 10-Ton WELDCO Mechanical Picklers, like the one shown above, were installed in this modern Indiana Harbor pipe mill, making it one of the largest pipe pickling installations in the country. The WELDCO Units in this plant provide fast, efficient flushing action, with better finish, uniform pickling and descaling, and big savings in manpower, maintenance, and steam consumption.

It will pay you to get all the details on WELDCO's complete line of Mechanical Picklers—available for Bars, Pipe and Tubing. Contact us for complete information, and for engineering service on your entire pickling line.

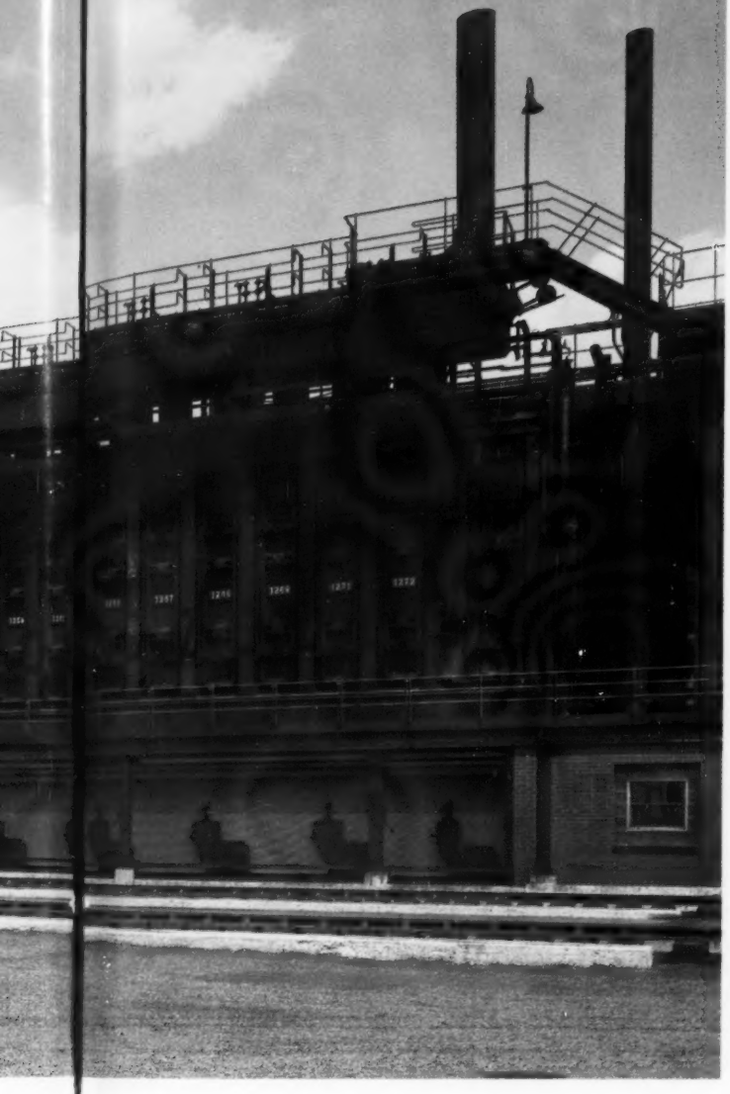
THE YOUNGSTOWN WELDING & ENGINEERING COMPANY
3719 OAKWOOD AVENUE · · YOUNGSTOWN 9, OHIO

Eastern steel plant now has

COAL HANDLING SYSTEM FOR THE COKE PLANT—Coal is conveyed to the breaker and balance building (center foreground), to the mixer and hammermill building, to the junction house (between stacks), and finally to the coal bin over the ovens.

65 NEW OVENS—These new ovens were furnished by Koppers, and were put into operation in June, 1957.

12 coke oven batteries, 758 ovens . . . ALL designed and built by Koppers



SEVEN 385-TON OPEN-HEARTH FURNACES were designed by Koppers for this giant plant.

A giant Eastern Steel Plant recently put into operation a new battery of 65 Koppers-Becker Underjet Coke Ovens. This coke oven battery is the twelfth at this plant—*all designed and built by Koppers.* This battery is designed for underfiring with either blast furnace or coke oven gas. It has a daily coal carbonizing capacity of 1,450 net tons, and gives the plant a total carbonizing capacity in excess of 15,000 tons per day. To help supply the expanded coke plant, a new coal handling system was designed and installed by Koppers.

At this same plant, Koppers contributed further to the expansion of facilities by designing and supervising construction of a new open-hearth shop, and the installation of soaking pits and a 45″ by 90″ Universal slabbing mill.

Repeat Orders Signify Satisfied Customers. Since 1907 Koppers engineers have been working with coke ovens: reducing operating costs . . . increasing yield of chemicals . . . improving heating control. Koppers has built the majority of coke ovens in the United States. Most of this business, like the 12 batteries built for this Eastern Plant, has been repeat business—the kind you get only if your product has given satisfactory service.

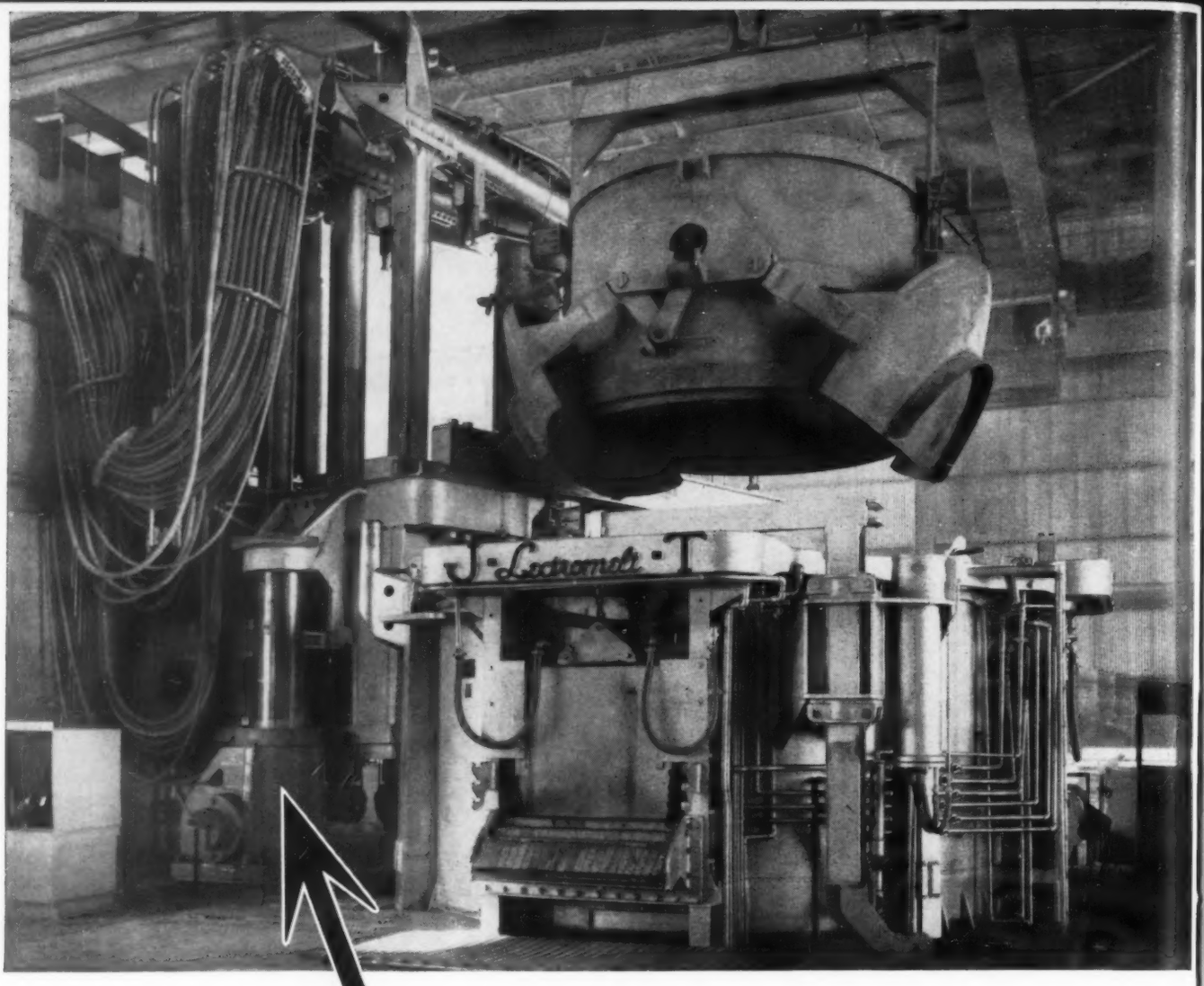
Koppers coke plant layouts are engineered to fit individual requirements and to solve all coke plant problems dealing with coal preparation and handling, coal-chemical recovery, light oil purification and refining, phenol recovery, and associated processes. Koppers also welcomes repair and replacement work for coke ovens and auxiliaries.

If you want help or advice with any steel-plant expansion program, call on Koppers.

KOPPERS®

50 YEARS OF ENGINEERING AND CONSTRUCTION SERVICE 1908···1958

KOPPERS



Separately mounted roof lift-and-swing mechanism on Lectromelt Furnaces . . .

Offers these advantages

★ **No heavy parts attached to furnace shell to cause strain and distortion**

★ **No jarring of roof, electrode arms or ram parts when heavy charges are dropped into the furnace**

★ **Allows uniform heat radiation all around the shell**

★ **Roof lift mechanism is away from excess furnace heat**

★ **Roof can be lifted higher, permitting larger charges**

★ **Shells can be readily interchanged**

* * *

All good reasons for specifying Lectromelt furnaces. They're described in Catalog No. 10. Lectromelt Furnace Division, McGraw-Edison Company, 310 32nd Street, Pittsburgh 30, Pennsylvania.

STANDARD SIZES UP TO TWO HUNDRED TONS CAPACITY

Lectromelt® McGRAW EDISON

CANADA: Canefco Limited, Toronto... ARGENTINA: Master Argentina, Buenos Aires... ITALY: Forni Stein, Genova... ENGLAND: Electric Furnace Co., Ltd., Weybridge... GERMANY: Demag-Elektrometallurgie, GmbH, Duisburg... SPAIN: General Electrica Espanola, Bilbao... FRANCE: Stein et Roubaix, Paris... BELGIUM: S. A. Stein & Roubaix, Bressoux-Liege... JAPAN: Daido Steel Company, Ltd., Nagoya

Standardization of traveling crane electric control circuit would simplify crane operation, maintenance and the selection of new equipment . . . . savings would result, and there is a possibility for standardizing a single circuit for the trolley and the bridge . . . . dynamic braking is preferable to plugging and the use of metallic rectifiers simplifies the dynamic braking circuit of series motors.

Standardization of Steel Mill Crane Control Systems

by K. S. Kuka,

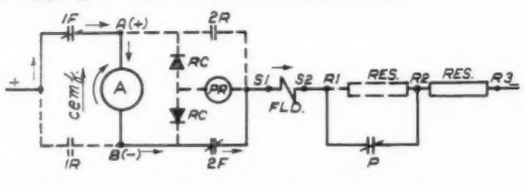
Assistant Chief Engineer (Electrical), The Tata Iron & Steel Co. Ltd., Jamshedpur, India

IN the material handling equipment field, electrically-operated traveling cranes play a most vital role in keeping the steel and its products moving through the steel works. Though the traveling cranes do not take a direct part in the making and shaping of steel, they constitute a substantial investment in capital. Also, on their trouble-free service depends the quick movement of materials through the major shops.

Both d-c as well as a-c motors can be used on traveling cranes. In American steel plants, however, d-c, 230-volt, series motors have been standardized for crane service. As a result, d-c controls are the best developed electric controllers for steel mill cranes. Many manufacturers have participated in their development.

Each manufacturer claims specific advantages for the control schemes standardized by his company. Their steel mill customers have the problem of making a selection.

Figure 1 — Power connections for forward motoring in a plugging circuit of a d-c series motor.

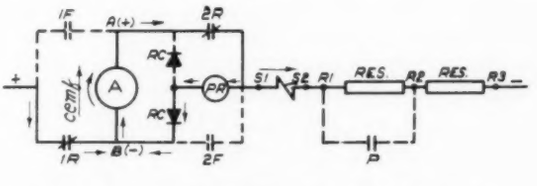


1F-2F-FORWARD DIRECTION CONTACTS CLOSED.
R1-R2-PLUGGING RESISTOR SHORTED BY PLUGGING CONTACT P.
PR-PLUGGING RELAY REMAINS DE-ENERGISED.
RC-RECTIFIERS FOR PLUGGING RELAY CORRECT CONTROL.
(FULL LINE INDICATE THE CURRENT FLOW-MOTOR C.E.M.F. OPPOSES THE LINE VOLTAGE.)

The development of crane control circuits has progressed to such an extent that it is now possible to standardize them. As far as the cranes are concerned, the steel industry today has standards for d-c motors and brakes, electrical wiring and mechanical-structural designs. If a standard for crane electric controls was made available, it would very much simplify crane operations, maintenance and the selection of new equipment. Large savings would be realized in modern integrated steel works with their scores of traveling cranes.

An overhead traveling crane normally has three major motions, the cross-traverse or trolley motion, the long-traverse or bridge motion, and the hoist or the hook motion. The control schemes for the trolley and bridge motions are essentially similar, and the possibility of standardizing a single control circuit for these two motions is very good.

Figure 2 — Power connections for plugging the forward-running, series d-c motor of Figure 1.



1R-2R-REVERSE DIRECTION CONTACTS CLOSED.
R1-R2-PLUGGING RESISTOR INTRODUCED.
PR-PLUGGING RELAY ENERGISED KEEPING CONTACT P OPEN.
(FULL LINE INDICATE CURRENT FLOW-MOTOR C.E.M.F. ADDS TO THE LINE VOLTAGE.)

CRANE TRAVERSE MOTION'S REVERSING, PLUGGING CIRCUITS

Adopted by all the control manufacturers, the system of controls for the traverse motions of cranes is the reversing, plugging control of a series-connected d-c motor. With such a control, the crane motion is braked by quickly reversing the master switch. This connects the electric motor for the reversed direction of rotation by reversing the connections of either its armature or its series field. As a result the motor develops torque in opposition to the motion of the crane. This torque brings the crane to a standstill and will accelerate it in the reverse direction of its motor remains connected to the power source. Because the motor would draw a very large current from the power line without it, an additional resistance (called a plugging resistance) is put into the circuit to limit the heavy current during the period of plugging.

The diagrams in Figure 1 illustrate the circuits formed when a motor is plugged while running in one direction. It is understood that during the process of plugging, the motor armature counter-emf is in the same direction as the line voltage tending to increase the current. However, the insertion of the plugging resistor into the circuit limits this current.

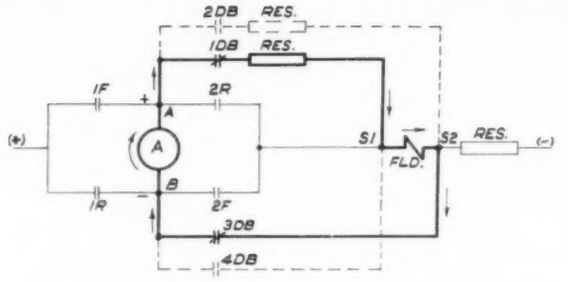
There are many different plugging relay circuits developed by the different control manufacturers. The plugging relay is designed to provide smooth deceleration of the crane motion during plugging. The plugging system of control requires an understanding of the electrical polarities of the circuit connections and the characteristics of the special plugging relay.

The operation of a plugging relay in one well known scheme is explained in Figure 2. When the motor is plugged from its forward motion by reversing the master switch, the reverse directional contacts, 1R and 2R, close. Nevertheless the motor armature continues rotating in its forward direction due to the momentum of the crane motion. Because the motor field remains excited in the same direction, the motor armature terminal "A" remains positive and the motor counter-emf adds to the line voltage instead of opposing it. The plugging relay coil PR is also energized. The current through its coil flows in the direction of the arrows shown in Figure 2. The relay PR controls the operation of the plugging resistance contactor P. The contacts P remain open as long as the relay PR remains energized. The resistance step R1-R2, called the plugging resistance, thus remains in the circuit to limit the motor current during the plugging period.

CRANE TRAVERSE CONTROL—REVERSING, DYNAMIC BRAKING CIRCUITS

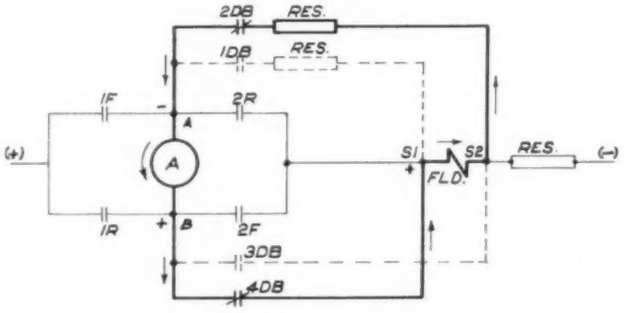
A simpler and smoother method would be regenerative or dynamic braking of the motor to decelerate the motion. With this method the motor is so connected that it becomes a self-excited generator driven by the crane momentum, i.e., a brake is applied to the crane motion. The braking action is smoother, because the magnitude of the dynamic braking torque depends on the initial speed of the crane.

The dynamic braking control schemes have not been generally accepted for steel plant cranes because more



ALL DIRECTIONAL CONTACTS 1F-2F, 1R-2R OPEN.
DYNAMIC BRAKING CONTACTS 1DB-3DB SPRING CLOSED.
DYNAMIC BRAKING CONTACTS 2DB-4DB LATCHED OPEN.
(THICK LINES INDICATE CURRENT FLOW-SERIES FIELD ENERGISED IN POSITIVE DIRECTION) (ARMATURE TERMINAL A BEING POSITIVE)

Figure 3 — Power connections for "off" point, dynamic braking of a series d-c motor rotating in the forward direction.



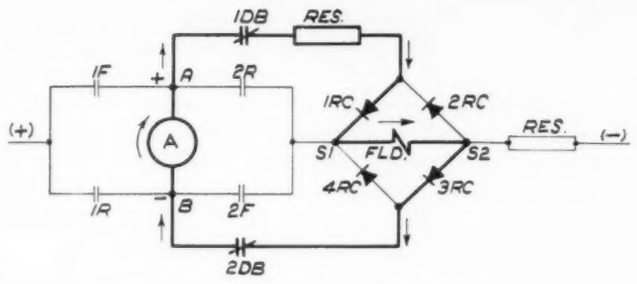
ALL DIRECTIONAL CONTACTS 1F-2F, 1R-2R OPEN.
DYNAMIC BRAKING CONTACTS, 2DB-4DB SPRING CLOSED.
DYNAMIC BRAKING CONTACTS, 1DB-3DB LATCHED OPEN.
(ARMATURE TERMINALS B BEING POSITIVE)
(THICK LINES INDICATE CURRENT FLOW-SERIES FIELD ENERGISED IN POSITIVE DIRECTION)

Figure 4 — Power connections for "off" point dynamic braking of a series d-c motor rotating in the reverse direction.

complicated circuits are required with a d-c series motor for dynamic braking action in both directions of rotations.

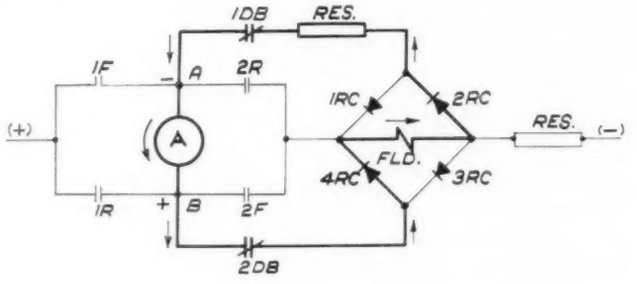
Several dynamic braking control schemes which use spring-closed polarized contactors, that are latched either magnetically or mechanically for proper sequential operation, have been developed. The diagrams in Figures 3 and 4 illustrate the circuit connections for dynamic braking of a d-c series motor in both directions. The spring-closed contactors 1DB, 2DB, 3DB and 4DB have to be specially designed to give the dynamic braking circuit in both directions of motor rotation. The criterion is that the series field of the motor be so connected with respect to its armature that the current through it is in the same direction for both directions of rotation so as to permit the d-c series motor to operate as a self-excited d-c generator. Figure 3 shows the circuit conditions for forward direction, and Figure 4 for the reverse direction.

The advent of the modern rugged and heavy duty metallic rectifiers has made possible the development of a new circuit that can give the required dynamic braking action without the use of latched contactors. The diagrams in Figures 5 and 6 show the circuits that provide the motor regenerative action when the contacts 1DB and 2DB are closed, and the motor disconnected from the power lines. This arrangement of the rectifiers in the bridge circuit permits the series field current to



ALL DIRECTIONAL CONTACTS 1F-2F, 1R-2R OPEN.
DYNAMIC BRAKING CONTACTS 1DB-2DB SPRING CLOSED.
RECTIFIERS 1RC-3RC PERMIT CURRENT FLOW.
RECTIFIERS 2RC-4RC BLOCK CURRENT.

Figure 5 — Power connections for "off" point dynamic braking of a series d-c motor rotating in the forward direction with a power circuit that includes a metallic rectifier bridge.



RECTIFIERS 2RC-4RC PERMIT CURRENT FLOW.
RECTIFIERS 1RC-3RC BLOCK CURRENT.
SERIES FIELD ENERGISED IN POSITIVE DIRECTION.

Figure 6 — Power connections for "off" point dynamic braking of a series d-c motor rotating in the reverse direction with a power circuit that includes a metallic rectifier bridge.

flow in the same direction, a fundamental condition for a d-c series motor to become a self-excited d-c generator when the motor armature is kept rotating. Figure 5 shows the current flow for the forward direction, and Figure 6 is for the reverse direction. The simplicity of the circuits in Figures 5 and 6 is easily recognized as compared to those in Figures 3 and 4.

AISE STANDARD FOR BRAKES IN TRAVERSE MOTIONS

Article 38 of AISE Standard No. 6 gives the requirements of mechanical brakes for the crane trolley and bridge. These requirements are:

For trolley brakes—"Where specified, trolleys with anti-friction bearings shall be provided with either a mechanical drag brake or an under-sized magnetic brake."

For bridge brakes—1. "Each bridge drive shall be equipped with hydraulic brake or brakes of sufficient size to stop the crane within a distance in feet equal to 10 per cent of full load speed in feet per minute, when traveling at full speed with full load."

2. "If specified on the information sheet, all cranes with bridge drive designed for more than 300 fpm bridge speed shall be provided with safety dynamic braking for the bridge motor which will provide automatic braking in both directions upon power failure. Such dynamic braking will be in addition to the hydraulic brakes."

3. "If specified, cranes shall be provided with electro-hydraulic brakes on the bridge drives, so arranged that the brake will be set when the main disconnecting switch on the foot-walk or in the cab is opened."

The above stipulations of the AISE Standard for electric, overhead traveling cranes for steel mill service indicate that a mechanical brake is a necessity for crane traverse motions. The specification stipulates a hydraulic or an electrohydraulic brake in preference to a shunt or a series brake.

The experience of the crane operators will, however, indicate that for service reliability an electro-mechanical d-c series brake is more robust and simpler because its action is positive and its operation instantaneous when the power is disconnected.

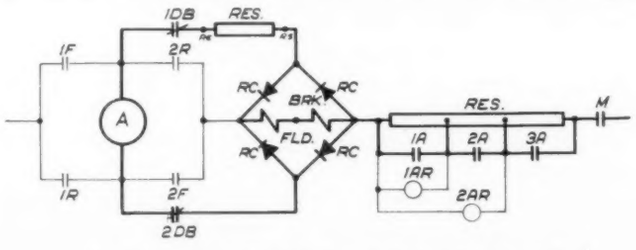
With a reversing plugging type of control circuit, however, a series brake drops off every time the controller is reversed to alter the motion. Such brake operations for an overhead trolley or bridge become a nuisance because they cause jerking and swinging of the load on the crane hook. This creates difficulties for the crane operator and may be dangerous if the load slips off the hook.

In the United Kingdom, shunt brakes are preferred to hydraulic brakes because of the maintenance problems encountered in keeping a hydraulic brake in effective condition. It would be revealing if a statistical study were made to ascertain how the crane hydraulic brakes in service are maintained in various steel plants. In the plant in which the author works, almost all the hydraulic brakes fail within a short time because of their failure to function effectively under the prevailing conditions.

NEW REVERSING, DYNAMIC BRAKING CIRCUIT WITH SERIES BRAKES

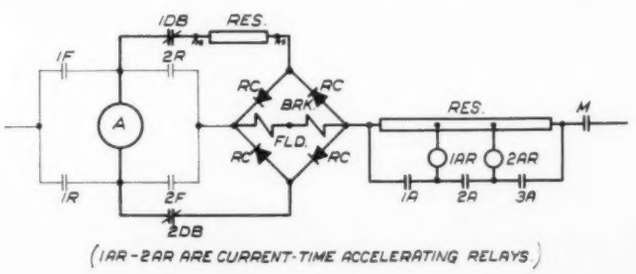
The circuits of Figures 5 and 6 permit the use of the simple series brake yet give all the braking requirements

Figure 7 — Reversing, dynamic braking circuit with inductive time limit acceleration and metallic rectifier bridge.



(1AR-2AR ARE INDUCTIVE TIME LIMIT ACCELERATING RELAYS.)

Figure 8 — Reversing, dynamic braking circuit with current time limit acceleration and metallic rectifier bridge.



(1AR-2AR ARE CURRENT-TIME ACCELERATING RELAYS.)

to a crane traverse motion as specified in Article 38 of AISE Standard No. 6 for steel mill cranes.

The diagrams in Figures 7 and 8 give the main circuit connections with directional, accelerating and dynamic braking contactors, accelerating relays, and a series-type, electro-mechanical brake. Figure 7 gives the connections for inductive-time relay acceleration, and Figure 8 gives the current-time acceleration. In both, standard types of relays can be effectively used without any fundamental changes in the control circuit.

The dynamic braking contactors are spring-reset magnetic units that close positively on power failure and provide instant dynamic braking in both directions of travel. The series brake brings the motion to a stop when the crane has slowed down to a set limit. Thus the application of dynamic braking as well as the mechanical braking is automatic and independent of the crane operator and provides a very smooth and uniform braking action.

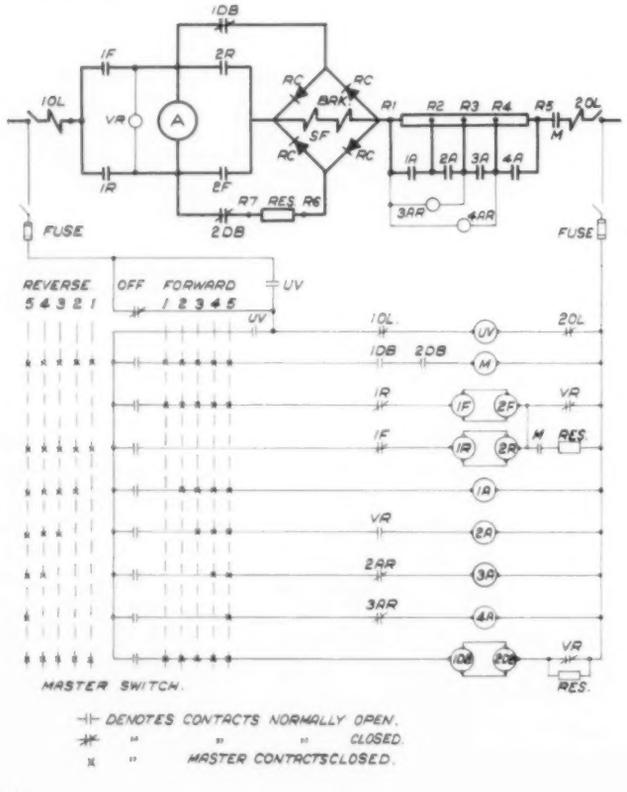
The resistance step R5-R6 in the dynamic braking circuit of Figures 7 and 8 is adjusted to get the desired braking effect at the rate of deceleration required. At low speeds the extent of dynamic braking is reduced. The effect on the series electro-mechanical brake is such that brake shoes apply a graduated braking action until the current goes down low enough for the brake to grip tight.

This circuit provides the most desirable braking action for both bridge and trolley motions under all conditions.

NEW DYNAMIC BRAKING, REVERSING CIRCUIT WITH SERIES BRAKE

Figure 9 gives a complete control scheme for crane traverse motions, both trolley and bridge drives, using a series type AISE standard electro-mechanical brake. The control circuit is designed to give dynamic breaking, anti-plugging control. The counter-emf relay VR is connected across the armature of the motor. This relay has three contacts, one normally open and two normally closed. The normally closed contacts control the directional contactors as well as the dynamic braking spring-reset contactors. The normally open contact of VR give the first automatic accelerating sequence.

Figure 9 — Proposed reversing, dynamic braking control scheme utilizing a metallic rectifier bridge for crane traverse motions.



The sequence of operation for the new circuit is as follows:

a. *Off position*—The control is deenergized, and the dynamic braking spring-set contacts are closed. The brake is also deenergized to hold the crane in a standstill position.

b. *Forward motion*—In forward motion, the directional contactors 1F and 2F are energized in the first-point of the master switch with all the resistances in the circuit. The dynamic braking contacts 1DB and 2DB open simultaneously with the directional contacts. The motor armature with its series field and series brake is connected across the power line. The rectifiers in both legs of the bridge circuit are connected in the blocking directions so that the current flows straight through the series field circuit. The resistances R1-R5 are such as to deliver a starting motor torque of about 60 to 80 per cent. This will overcome the static friction and accelerate the crane. The resistance step R1-R2 can be adjusted to the required starting torque of the crane.

On the second point of the master switch, the 1A contact closes. This brings the crane up to about 40 per cent full load speed. When the crane speed approaches about 35 per cent, the voltage relay VR pulls in and closes its contacts permitting energizing of the second accelerating contactor 2A. On the third point of the master switch, the contacts 2A close and accelerate the crane still further. The accelerating relays, 3AR and 4AR, compel the crane motion to reach its maximum speed in sequence when the master switch is moved rapidly to the last point.

c. *Reverse motion*—In the reverse motion the sequence is exactly the same as in the forward motion except that the directional contactors 1R and 2R are operated.

d. *Off-point dynamic braking.* When the master switch is brought to the "Off" point, the directional contacts open and the contacts 1DB and 2DB close. As soon as the contacts 1DB and 2DB close, the armature is connected with the series field in proper direction as shown in Figures 5 and 6. The momentum of the crane motion mechanically drives the motor. It begins to generate power due to the inherent residual magnetism of the motor-field system and becomes cumulatively self-generating with its current limited by the resistance step R6-R7 in the dynamic braking circuit. The series brake remains released until the motion slows down. Slowing down reduces the dynamic braking action of the motor. When the motion is sufficiently slowed down, the brake holds the crane at standstill. The braking action, both regenerative as well as mechanical, is automatic and smooth. The crane can be stopped at a desired quick rate from any point on the speed curve of the crane.

If the crane operator tries to reverse the master switch to the opposite direction, the relay VR prevents the dynamic braking contacts from opening until the

motion is sufficiently slowed down to drop the relay VR. The relay VR is set to pull in at about 35 per cent voltage across the motor armature and drop out at about five per cent voltage.

The safety interlocking between dynamic breaking contactors and other contactors is provided over the auxiliary contacts to prevent heavy current kicks in case a contactor operates falsely due to failure of its coil. The failure of the VR coil is also immediately indicated. In that case the crane will fail to accelerate beyond the first point speed.

The new control scheme thus gives a simple method of controlling the trolley and traverse motions of a crane. Graduated dynamic braking for very heavy cranes can be easily had by the addition of a fluttering type current relay in series with the 1DB contacts and an additional contactor across the dynamic breaking resistance step. Thus the standard method of graduated dynamic braking can be had if desired.

STANDARDIZATION OF TRAVERSE MOTION CONTROL

The circuit in Figure 9 presents the possibility of adopting it as a standard circuit for both trolley and bridge motions on all steel mill cranes. Control manufacturers can easily apply his standard design of contactors and relays to this circuit. The customer is left free to select any manufacturer and at the same time maintain a standard circuit on all the cranes. Each manufacturer has the same opportunity to compete in the open market as the number of contactors, relays and resistances remain the same in every case. The competition will be solely on the basis of the quality of the contactors, the relays and the rectifiers.

The standardization of the circuit permits the use of the AISE standard electrical d-c series brakes for the crane traverse motions, the same as for the crane hoist motions. This simplifies the maintenance and spare parts problems of the brakes. The elimination of the hydraulic brakes will be a great advantage as the standardized series brakes are no doubt far superior in every respect to hydraulic brakes.

Because the application of the series brake to the new circuit makes it smooth and automatic, the operator's problems are also eased as he is not required to mind the braking operations at all. Even for the steel ladle teeming duty, the circuit in Figure 9 will give better load spotting and less load swinging.

The electro-mechanical series brake can also safely and conveniently be applied to all trolleys, especially ones for heavy steel melting shop cranes. This would eliminate the necessity of providing drag brakes as recommended in the AISE crane specification.

CRANE HOIST CONTROLS

The problems of the standardization of the crane hoist circuit are more difficult because the circuits adopted by the different manufacturers are widely different in details though following the same general principles to control a d-c series motor with dynamic braking lowering characteristics.

It would be, however, possible to arrive at generally acceptable standards for speed-torque characteristics of the crane hoisting-lowering duty cycles that will give the best possible load control.

After comparing the characteristics of the different hoist control circuits used on American steel mill cranes, it would be easy to adopt the following features as standard for all hoist controllers.

PROPOSED STANDARD FEATURES FOR A CRANE HOIST CONTROL

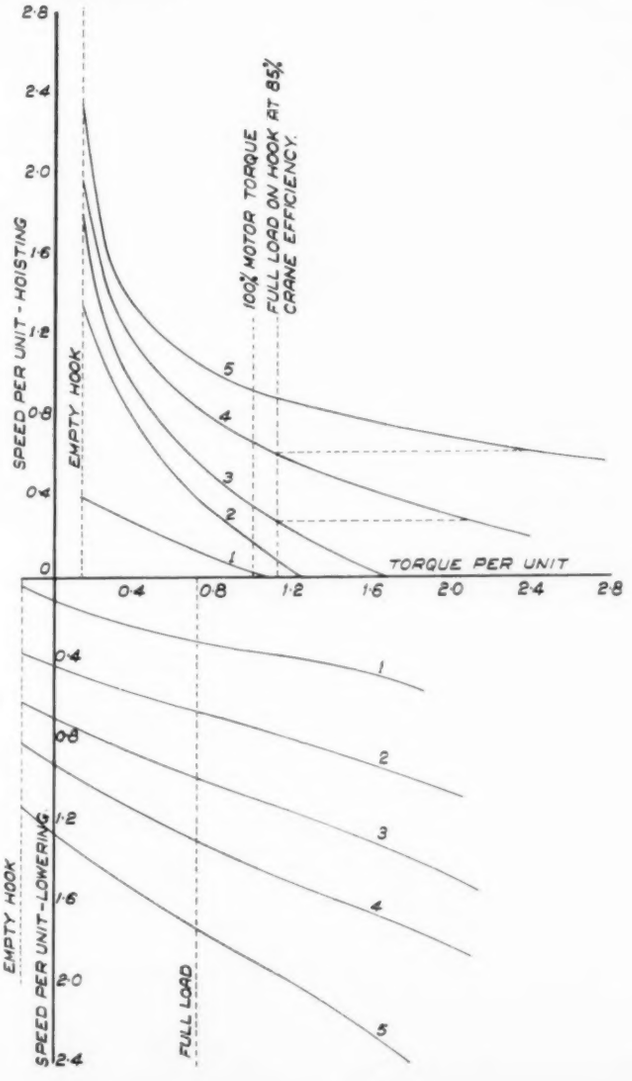
1. Each hoist controller should give five distinct and stable speed-torque curves both for hoisting and lowering cycles. The speed-torque curves should have as equal a spacing as possible and shall not intersect each other at any point from the light hook to about 125 per cent rated load of the crane.

2. The first-point hoisting shall give a stalling torque of 125 per cent rated load so that the load is prevented from drifting downwards.

3. The first-point maximum hoisting speed shall be maintained within about 40 per cent of the full load hoisting speed so that the slackness of the rope can be taken up smoothly without jerks or inching the control.

4. The hoist curves shall be so spaced that it would be

Figure 10 — Proposed speed-torque characteristics for a hoist controller.



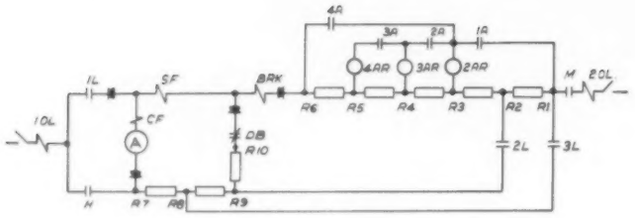
easy to lift rated load rapidly without creating heavy accelerating current kicks in the motor armature.

5. The first-point lower shall give a break-away torque to an empty hook and shall also provide a dynamic braking torque such that a 125 per cent rated load can be lowered at a speed not exceeding 40 per cent of the normal full load hoisting speed.

6. The last point lower shall give maximum stability to the motor and shall provide a braking torque such that a 125 per cent rated load can be lowered at a speed not exceeding 200 per cent of the normal full load hoisting speed.

7. The control circuit shall be designed such that the transient current peaks are maintained within 225 per cent of the motor's one-half hour rated full load current, and the transient torque peaks at the motor shaft are maintained within 250 per cent of the motor's one-half hour rated torque.

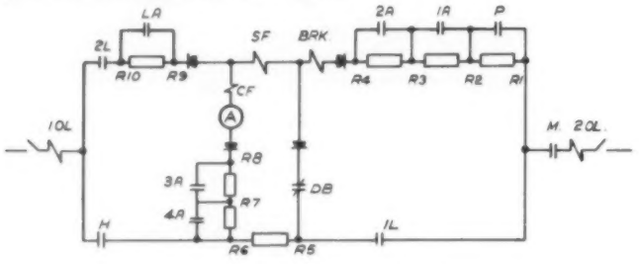
8. Means shall be provided in the control circuit that



CONTACTOR SEQUENCE
X DENOTES CONTACTS CLOSED.

	LOWER					OFF	HOIST				
	5	4	3	2	1		1	2	3	4	5
H							X	X	X	X	X
1L	X	X	X	X	X						
2L			X	X	X						
M	X	X	X	X	X		X	X	X	X	X
DB					X	X					
3L	X										
1A							X	X	X	X	
2A				X	X			X	X	X	
3A					X					X	
4A					X						X

Figure 11 — Square D Co., EC&M Div. power circuit and position connections for a hoist.

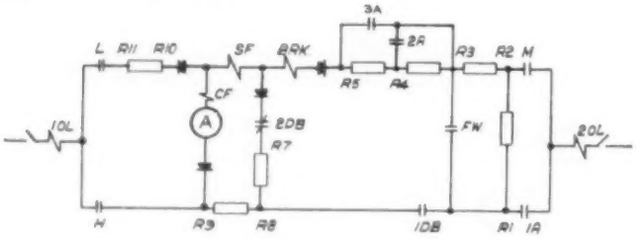


CONTACTOR SEQUENCE
X DENOTES CONTACTS CLOSED.

CONTACTS	LOWER					OFF	HOIST				
	5	4	3	2	1		1	2	3	4	5
H							X	X	X	X	X
1L	X	X	X	X	X						
2L	X	X	X	X	X						
M	X	X	X	X	X		X	X	X	X	X
DB						X					
P			X	X	X		X	X	X	X	
1A				X	X			X	X	X	
2A					X				X	X	
3A	X	X			X						X
4A	X	X			X						X
LA	X	X									

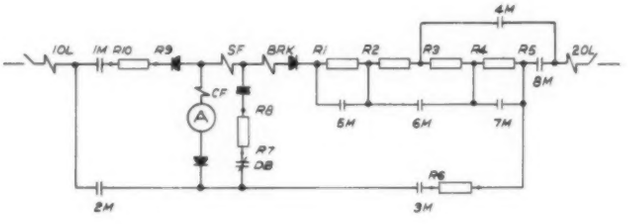
Figure 12 — Cutler-Hammer, Inc., power circuit and position connection for a hoist.

Figure 13 — General Electric Co. power circuit and position connection for a hoist.



CONTACTOR SEQUENCE
X DENOTES CONTACTOR CLOSED.

CONTACTS	LOWER					OFF	HOIST				
	5	4	3	2	1		1	2	3	4	5
H							X	X	X	X	X
L	X	X	X	X	X		X	X			
M		X	X	X	X		X	X	X	X	X
1DB	X	X	X	X	X						
2DB				X	X	X					
1A	X	X	X	X				X	X	X	X
2A									X	X	
3A			X	X	X						X
FW					X	X	X	X	X	X	X

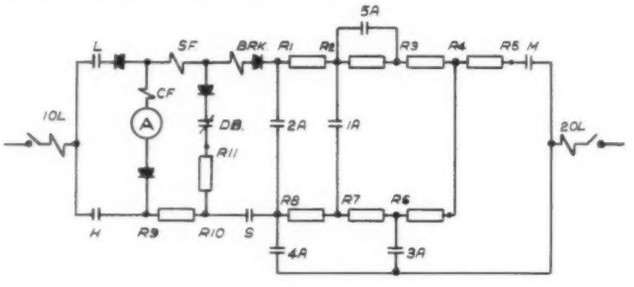


CONTACTOR SEQUENCE
X DENOTES CONTACT CLOSED.

CONTACTS	LOWER					OFF	HOIST				
1M	X	X	X	X	X		X				
2M							X	X	X	X	X
3M	X	X	X	X	X						
4M			X	X	X		X	X	X	X	X
5M					X			X	X	X	
6M				X	X				X	X	
7M			X	X	X						X
8M	X	X	X	X	X						X
DB				X	X	X					

Figure 14 — Westinghouse Electric Corp. power circuit and position conection for a hoist.

Figure 15 — Clark Controller Co., Inc., power circuit and position connection for a hoist.



CONTACTOR SEQUENCE.
X DENOTES CONTACTS CLOSED.

CONTACTS	LOWER					OFF	HOIST				
	5	4	3	2	1		1	2	3	4	5
H							X	X	X	X	X
L	X	X	X	X	X						
DB					X	X	X				
M			X	X	X		X	X	X	X	X
S	X	X	X	X							
1A				X	X						
2A									X	X	X
3A			X							X	X
4A	X	X	X								X
5A		X	X	X	X			X	X	X	X

will self-protect the crane against excessive over-speeding due to failure of any contactor, relays or the overhoist limit switch.

9. The main circuit should be so designed that preferably a maximum of nine contactors and seven resistance steps are used.

REFERENCE SPEED-TORQUE CURVES

After a close study of the various control schemes, it is suggested that the curves given in Figure 10 be adopted as standard reference speed-torque curves for the crane hoist system.

PROPOSED STANDARD MAIN CURRENT CIRCUIT

The aim of the standardization should naturally be to arrive at the circuit which could be made acceptable to a majority of the manufacturers. The criterion naturally is that each manufacturer shall be in a position to adapt his standard equipment to the circuit and to easily obtain the required sequence of operation without complicating the electrical control circuit and thereby putting himself at a competitive disadvantage.

In Figures 11 to 15 is shown the main current circuit adopted by some of the leading control manufacturers of crane hoist controllers. A comparison of the circuits would lead to the possibility of developing a common circuit acceptable to all the parties concerned. This common circuit should incorporate the good features of each of the existing circuits and should at the same time make it possible to give a straightforward contactor operating sequence, stabilized speed-torque curves and a simple and self-protective control circuit.

After a long study the author has developed a hoist circuit that meets all the important requirements of the crane hoist controller and which was evolved as a compromise between the different existing control schemes. The author proposes that the new circuit be adopted as a standard for the steel mill crane hoist controller.

Figure 16 gives the proposed main current circuit for crane hoist controls as a standard of reference. Figure 17 gives the step-by-step sequential development of the circuit for hoisting and lowering cycles.

It will be agreed by all the steel mill crane operators and the control designers that the proposed circuit does give a neat solution to crane hoist control by providing a straightforward and simple arrangement of resistance steps and contactor sequence. It also gives speed-torque curves approximating those in Figure 10.

If the main circuit of Figure 16 is accepted as standard, the control circuit can be left to the individual manufacturer to apply his standard equipment to the best advantage. Further, if the main current circuit is accepted as a standard, it would then be possible to evolve a control circuit which could be provided with certain specific features.

In Table I the author has given the comparative number of devices used by the manufacturers in their hoist controllers. The number of devices that are required for the new circuit is shown in the last column of

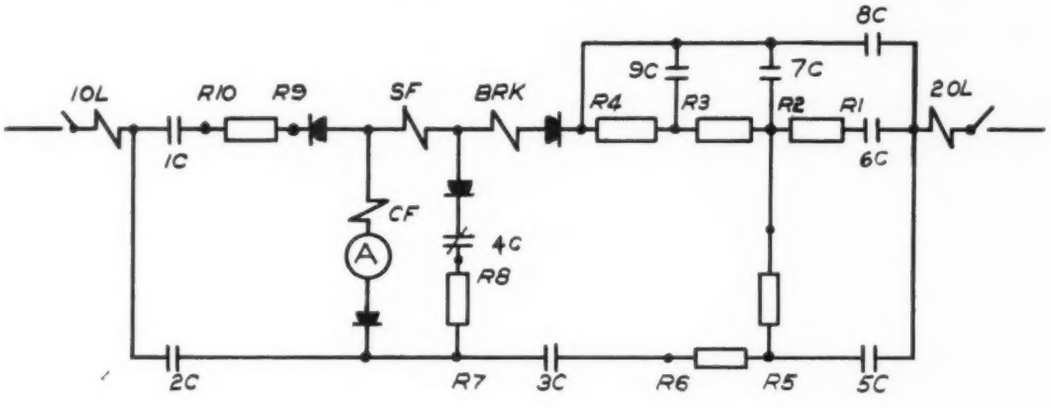


Figure 16 — Proposed standard hoist circuit. Elementary diagram of main current circuit indicates contact closing sequence.

CONTACTOR SEQUENCE X-DENOTES CONTACTS CLOSED												
CONTACTS	LOWER					OFF	HOIST					
	5	4	3	2	1		1	2	3	4	5
1C	X	X	X	X	X		X				
2C							X	X	X	X	X
3C	X	X	X	X	X						
4C					X	X					
5C	X	X	X	X					X	X	X
6C				X	X		X	X	X	X	X
7C			X	X	X					X	X
8C											X
9C		X	X	X	X	X	X	X	X	X	X

NOMENCLATURE	
A	MOTOR ARMATURE
CF	COMMUTATING FIELD
SF	SERIES FIELD
BRK.	SERIES BRAKE
OL.	OVERLOAD RELAY
2C-3C	MECHANICALLY INTERLOCKED
1C-8C	" "
	TROLLEY CROSS BAR COLLECTOR
	NORMALLY OPEN CONTACTS.
	" CLOSED "

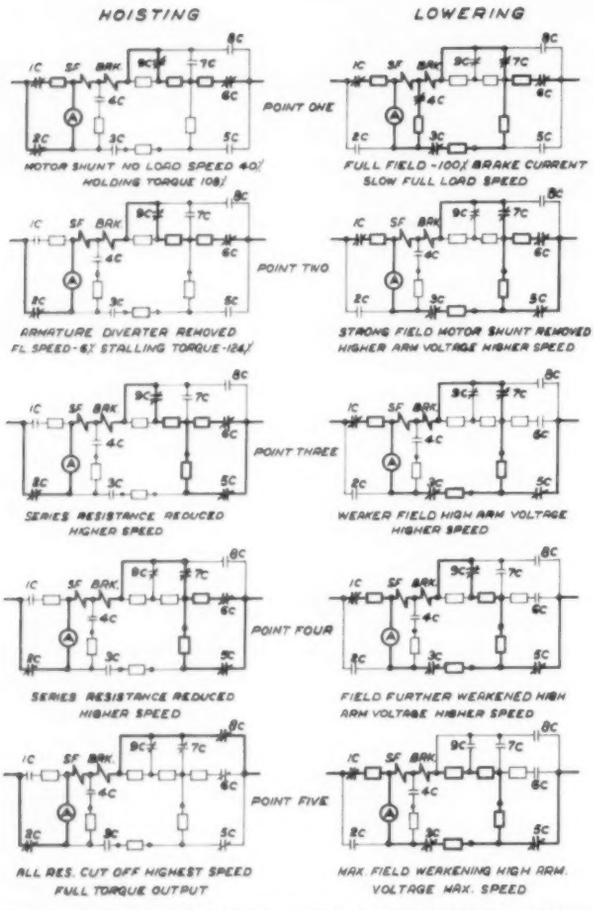

HOISTING
LOWERING
POINT ONE
MOTOR SHUNT NO LOAD SPEED 40% HOLDING TORQUE 10%
FULL FIELD -100% BRAKE CURRENT SLOW FULL LOAD SPEED
POINT TWO
ARMATURE DIVERTER REMOVED FL SPEED-67% STALLING TORQUE-124%
STRONG FIELD MOTOR SHUNT REMOVED HIGHER ARM VOLTAGE HIGHER SPEED
POINT THREE
SERIES RESISTANCE REDUCED HIGHER SPEED
WEAKER FIELD HIGH ARM VOLTAGE HIGHER SPEED
POINT FOUR
SERIES RESISTANCE REDUCED HIGHER SPEED
FIELD FURTHER WEAKENED HIGH ARM VOLTAGE HIGHER SPEED
POINT FIVE
ALL RES. CUT OFF HIGHEST SPEED FULL TORQUE OUTPUT
MAX. FIELD WEAKENING HIGH ARM. VOLTAGE MAX. SPEED
THICK LINES DENOTE PART OF THE CIRCUIT CARRYING CURRENT AT EACH POINT.

Figure 17 — Power circuit connections of each position of master switch in Figure 16.

the table. The number of relays required by the proposed circuit is as follows:

a. Over-current relays—2
b. Under-voltage relay—1 (as main voltage control relay)
c. Accelerating relays—2 (both during hoisting and lowering)
d. Decelerating relays—2 (one during hoisting and one during lowering)
e. Anti-cycling and over-speed relay—1 (for protection against over-hoist limit switch operation)

SUMMARY

The main object of this paper is to place before the steel mill electrical operators, who face the problems of maintenance of steel mill cranes, certain definite aspects of crane control schemes whose standardization would simplify the problems of crane operation, maintenance and spares.

Among the finest achievements of the Association of Iron & Steel Engineers has been the formulation of accepted industry-wide standard specifications for equipments used in the steel industry.

As far as the electric overhead traveling cranes are concerned, standards for motors, brakes, limit switches, crane general design, and electric wiring have been adopted for some years and accepted by the industry.

If the standards for electric control circuits can be devised to get the acceptance of all interested parties, they will definitely be an achievement and a great gain to the industry.

TABLE I
Comparison of the Devices Used on Different Hoist Controllers

Type	Main contacts	Contactor-coils	Resistance steps	Relay coils	Relay contacts	Auxiliary contacts
E. C. & M. Div. of Square D Co.	10	11	8	7	9	14
Cutler-Hammer, Inc.	10	14	6	3	4	6
General Electric Co.	9	9	7	8	15	12
Westinghouse Electric Corp.	9	9	7	9	11	12
The Clark Controller Co.	10	10	9	8	14	17
Figure 16 (proposed standard)	9	9	7	8	15	13

This paper is a result of nearly 20 years of operating experience and constant work on crane control schemes. It is an attempt to set the problems of proposed standardization before the steel mill engineers in a concrete form.

Discussion

PRESENTED BY

H. M. COOK, Manager, Crane and Mill Accessory Controls Div., The Clark Controller Co., Cleveland, Ohio

L. H. JOHNSON, Supervisor Product Section, Systems Control Sales Div., Cutler-Hammer, Inc., Milwaukee, Wis.

S. RIFKIN, Senior Application Engineer, Materials Handling Unit, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

A. H. MYLES, Chief Engineer, EC&M Div., Square D Co., Cleveland, Ohio

H. A. ZOLLINGER, Industrial Engineer, General Mill Section, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

K. S. KUKA, Assistant Chief Engineer (Electrical), The Tata Iron & Steel Co. Ltd., Jamshedpur, India

H. M. Cook: Mr. Kuka, who in the past has made many contributions to—let us say—the art of crane control systems, has made another worthy contribution at this time, in his paper, presenting a case for the adoption of standardized crane control systems.

The review of present practice and his proposed standardized circuits for hoist, bridge and trolleys of cranes certainly represents a great deal of thought and preparation by Mr. Kuka, and the accumulated data in one paper will be appreciated by many engineers and operating people concerned with the design and maintenance of crane control schemes.

The desire for standardization, although an admirable one and usually much wanted by many people, is one that cannot too easily be accomplished.

Having participated in the establishment of crane control standards by the Industrial Control Section of NEMA, we know that this business of arriving at standards, particularly on control systems, is not easily accomplished. Sections 43 and 44 of the Industrial Control Standards of NEMA, IC1-1954 represent what the control industry felt could be written into crane control standards without hampering or, in any way, stifling progress and ingenuity.

Mr. Kuka's examples of the use of rectifier to maintain undirectional flow of current through series fields on reversing bridge and trolley controllers, we believe, is quite indicative of the need to leave the door wide open for future progress and use of new components and materials. Although the art indicating the use of "valves" to maintain unidirectional flow of current is old, it was not until recent years, when reliable power rectifiers had become available, that it became practical or—let us say—safe to use rectifiers around the fields of series motors in order to simplify the problem of emergency dynamic braking on series motors in case of power failure. Our company has been promoting the use of power rectifiers in series field circuits for a number of years and can report many successful applications of them.

As to the proposed dynamic braking scheme for bridge and trolley motion, in which the series field and the brakes are in a rectifier bridge circuit, we do not feel that this would be as effective for stopping and spotting as a reversing, plugging controller, that is now more or less considered standard, nor is it any simpler.

What could be simpler than a reversing plugging controller with one less contact, no rectifier and tamperproof plugging relays to do the job?

Furthermore, Mr. Kuka indicates with the brake included in the rectifier bridge circuit, that in his dynamic braking scheme, that the series brake gives a graduated braking effect, because the torque delivered by the brake will increase gradually. Unless a special brake is provided with a careful choice of coils, we believe that most brakes will not release until the coil current drops down to 10 per cent or lower, and then the magnet is released completely putting practically full available torque on the brake.

On the matter of the use of hydraulic or mechanical brakes on bridges and trolleys, Mr. Kuka indicates that in the United Kingdom a great deal of use is made of shunt brakes instead of hydraulic or mechanical brakes. It would be of interest to many to know what the over-all experience has been, and how it compares with the use of hydraulic and mechanical brakes. Many of us have felt that shunt brakes could be provided to do the job because it is possible by proper design of the control circuit to make provision for time delay dropout of these brakes on operating reversal of the controllers and still make provision for instant setting for emergency braking or parking purposes.

The crane hoist circuit proposed by Mr. Kuka is certainly about as good a compromise, or—let us say—is one to which we could take very little exception. It is quite representative of most circuits being used today.

The only two points we might be inclined to argue with a bit would be No. 1—the stall torque required in the hoist on the first point requiring that it be equal to 125 per cent full load torque. This I do not believe to be entirely necessary as long as it is possible for the operator to—let us say—go to the second point hoisting and without contactor or relay sequence delay to cause 100 per cent or better torque to be delivered by the motor. I believe that this is more or less general practice at the present time and can be accomplished without too much difficulty or complexity. The second point concerns the use of a resistor in series with the dynamic lowering loop in the lowering direction. I well appreciate that this resistor has been indicated as necessary, in some of the prior art, in order to maintain stability of the motor when lowering heavy loads at high speeds.

This resistor results in the rather steep speed torque characteristics in the lowering direction, as shown not only in Mr. Kuka's characteristic curve for this system, but also as has appeared in literature of the art before. Our company has chosen not to use this resistor in series with the dynamic braking loop and thereby obtain much flatter speed-torque characteristics in the lowering direction. We feel that these flat characteristics are desirable.

As to the stability of the motor in this case, the motor is kept stable by avoiding excessive series field weakening. This can be accomplished by maintaining this field strength at above 40 per cent of its full load rating by proper design of the resistor values in series with this field.

As to the adoption of any standard hoist scheme, this would be rather difficult not only because it may be difficult to get a meeting of the minds of the general philosophy but also because any adopted scheme should be flexible enough so that one can obtain both the desirable extreme high speed lowering characteristics required by magnet and skull cracker cranes and still be good enough to permit the values to be adjusted for the very smooth acceleration without too much overspeed that is desired on hot metal cranes.

L. H. Johnson: It has been proposed by Mr. Kuka that a dynamic braking circuit be used on bridge and trolley controllers instead of the conventional reversing, plugging type of circuit presently used by all manufacturers. The circuit suggested by Mr. Kuka does not permit plugging and, in fact, will not permit restarting in the same direction before coming to a complete stop if the master switch is moved to the "Off" position. A voltage relay connected across the motor armature prevents restarting until the motor has been brought to a stop by dynamic braking.

We have tried graduated dynamic braking for service stopping on bridge and trolley service and have found it undesirable from the operator's standpoint. It has worked satisfactorily and is recommended for emergency stopping.

Mr. Kuka has indicated that the electro-mechanical brake will set gradually as the dynamic braking current decreases. Standard magnetic brakes do not function in this manner, but set instantaneously when the current through the brake coil drops to a certain value.

Any decision to standardize crane control circuits would obviously have to be made by the users rather than the control manufacturers. However, basic differences in accelerating contactors and relays will necessarily dictate some differences in the control schemes. All control manufacturers would not be able to line up with the number of contactor and relay contacts and coils listed for the proposed standard control in Table I. Furthermore, while standardization of crane control may simplify maintenance, it would tend to discourage development of new ideas that could prove to be advantageous from either a maintenance or operational point of view.

S. Rifkin: Once again Mr. Kuka has demonstrated his thorough knowledge of d-c crane control circuits and application requirements as well as his ability to write a

very interesting paper. (See AISE Yearly Proceedings of 1948, 1950 and 1956.)

Although we agree with the desirability of standardizing d-c mill motors and brakes, we have many reservations with regard to the desirability or even the feasibility of standardizing control circuits. The motor and brake standards establish a number of ratings and definite values for the most important dimensions thereby limiting the number of different sizes that each manufacturer need be prepared to supply and each user prepared to service. In addition, the number of different designs required from the machinery manufacturer is reduced. However, it should be noted that these standards make no attempt to impose other limitations. Consequently, it is possible for an electrical manufacturer to introduce design improvements such as the use of class H insulation in mill auxiliary motors without encountering the time consuming process of changing the standards. It is only necessary to change standards when major design innovations, such as the design and material improvements that led to the "600" mill auxiliary motor, are recommended.

Disregarding the desirability or feasibility of establishing standard circuits, perhaps a few comments concerning the circuits proposed in this paper may be of interest.

The rectifier dynamic-braking circuit illustrated by Figures 5 and 6 has been used quite successfully with a shunt brake that can be set when the operator desires or when power is lost. However, a self-excited dynamic-braking circuit has limitations that might not be desirable on many installations. It is not at all unusual for a trolley or bridge motor to attain a speed on the order of 250 or 300 per cent of the motor thirty minute rating. At the maximum speed, resistor R6-R7 in Figure 9 must have sufficient resistance to result in acceptable peak torque and peak current values when the braking circuit is established. With that amount of resistance, the armature voltage and the motor torque will drop to almost zero while the motor speed is still on the order of 100 per cent. Because the remainder of the stopping torque would be provided by the brake, consideration must be given to brake wheel heating and to brake lining life if frequent operation is involved. Consideration must be given, also, to the peak torque and current obtainable if the operator plugs the master switch beyond the first point, since the VR relay may drop out at a comparatively fast motor speed, allowing the reverse directional contactors to pick up with the 1A contactor closed.

As far as the hoist circuit is concerned, we feel highly complimented, since most of the standard features suggested by Mr. Kuka have been included in our control. See 1950 proceedings AISE. Even though complete factory and steel mill tests were made before publishing that paper there have been some circuit improvements since that time. There have been several special applications utilizing modifications of the basic circuit. This illustrates one of the drawbacks of establishing standard circuits. There would be less incentive for the various manufacturers to work on circuit improvements. (Incidentally, there is a minor error in Figure 13. Contactor 2A should be connected across R3-R4 instead of R4-R5.)

Considering the fact that crane maintenance personnel must become familiar with the different construction of devices on panels supplied by various manufacturers, the advantage of adopting a standard circuit becomes questionable. This is especially applicable to the hoist motion, for which it is proposed that only the power circuit be defined with the control circuit left to the individual manufacturer.

At the present time, AISE Standard No. 6 refers to NEMA Standards for crane control, which establishes contactor ratings, number of accelerating steps, plugging protection, etc. On severe duty applications, some steel mills will order higher capacity contactors or more steps than required by these standards, but there is no objection to this practice since the NEMA Standards are only intended to establish minimum requirements. However, there are many other areas in which there will be plant-by-plant differences, even within the same steel company. A plant with a grounded negative d-c power system may insist that the motor series field and the series brake coil be connected as near to the negative side of the line as possible. On the other hand, a plant with an ungrounded system may prefer to have the series field and series brake between the armature on the positive side and the resistors on the negative side. One plant may require an instantaneous overload relay coil on each side of the circuit, but another plant may have both an instantaneous and an inverse time overload relay coil on the same side of the circuit. Many other differences exist, and, until these differences can be resolved, it does not seem very likely that agreement can be obtained with regard to standard crane control circuits.

A. H. Myles: I would like to compliment Mr. Kuka on his excellent paper on steel mill d-c crane control. It is certainly indicative of the many years he has studied this operation.

The author's recommendation for standardization of d-c crane control circuitry would certainly appear to have very decided advantages, particularly from the user's point of view. However it might be well to review the basis for present standardization of motors, brakes, etc. These standards are primarily of a dimensional value nature to provide interchangeability of units. With respect to crane circuit standards it is perhaps questionable whether such standards could also include controller dimensions.

Since control circuitry has no problem of mechanical mounting and alinement and is already standardized as to contactor capacity, we might weigh the advantages of further standardization against the possible restriction on improving design. Certainly no control engineer would make a statement that any present circuit cannot be improved.

In our application of control to crane bridge and trolley drives we find a wide difference of opinion by users as to reversing-plugging; reversing nonplugging dynamic braking; reversing-plugging with service dynamic braking; ability to drift at the "Off" position etc. For personality reasons only—even if control builders were agreeable—it would seem improbable that strict standards could be adhered to.

The author's proposed standard circuitry certainly has some merit but would require considerable compromising. The use of series brakes on bridge and

trolley drives, as proposed by the author, does not permit the use of a drift point. It is possible to take the swing out of a load and provide more accurate spotting with a reversing plugging controller that allows drifting than by stopping with a self-excited dynamic braking circuit and a series brake. A series brake, according to AISE standards, must remain released down to 10 per cent full load current. When it sets, the amount of magnetism tending to release it is less than 10 per cent so that the "cushioning" effect is negligible. With the self-excited dynamic braking circuit, the necessary sequence interlocking between the negative line contactor and the spring-closed dynamic braking contactors in a self-excited dynamic braking circuit is a detriment to inching and to the ability to spot loads or take out swing.

With self-excited dynamic braking, the retarding torque decreases rapidly with decrease of speed. If then, the dynamic braking resistors were designed to keep the peak current at high speeds within the limitations of the motor, the retarding torque at 10 per cent current (brake setting value) would be very low. An additional point of deceleration or a fluttering dynamic braking contactor of the series coil type, or equivalent, would be necessary to stop the bridge or trolley at the same rate as would a reversing-plugging controller.

Plain reversing-plugging control with self-excited dynamic braking effective only on loss of power to the motor and a shunt wound parking brake would appear to provide the maximum in operation and safety even for hot metal cranes.

In the design of hoisting circuitry there is naturally much compromising between desired performances and simplicity, motor abuse, safety, brake operation, and low maintenance. Again personal opinion often decides which should be the predominant factors. Even then such decisions may be different from one application to another. For example, the hoist control for magnet cranes, stripper cranes, many soaking pit cranes, and the holding lines of bucket cranes (all of which continually have heavy overhauling loads), does not require the additional equipment necessary to give light hook, high speed lowering.

The author does not show the control circuits used for the dynamic lowering control but does specify a deceleration relay for lowering. I would assume that the circuit to the deceleration relay would have to by-pass the master switch contacts; and should a fault prevent the relay from functioning, the load could continue to lower.

Before any new crane control should be considered for a standard, the complete power and control circuit should be tested by each manufacturer on their own test tower as well as in field service to be sure the difference in characteristics of the manufacturer's devices do not create unsafe or false operating conditions.

From the viewpoint of a control manufacturer, we would not wish to see any standardization that would impede advancement of the art of crane control with respect to performance, safety, simplicity, and quality of components.

H. A. Zollinger: The ultimate user of steel mill crane control has a very definite problem in educating his operating and maintenance personnel on the different hoist, trolley and bridge control systems. The effort put forth by the author to start a standardization of the crane control systems should be well recognized and not passed over too lightly. The biggest problem is to get the steel industry to state what they want as a standard scheme before any action is taken by the electrical manufacturers. My reason is each manufacturer has developed his scheme for what he feels are the most advantageous points to smooth operating, low maintenance crane control.

The trolley and bridge drive scheme using dynamic braking rather than plugging looks much simplier when the bridge rectifier is used for the series field and the series brake. The idea looks good and I would personally like to see a crane operate with this exact circuitry. The only shortcoming in the circuit is it does not provide a number of dynamic braking points as is provided by a number of plugging points on the standard reversing plugging control. This can be done by adding contactors in the dynamic braking circuit, but the control tends to become more complicated.

The speed-torque curves presented for a standardized hoist drive show well balanced and evenly spaced speed torque curves. The use of an armature shunt point on the first master switch point hoist has been argued for many years. It is a very desirable speed-torque curve to have and requires less skill to position full load than if the armature shunt point were omitted and a reduced torque point provided in its place. The only argument for omitting the armature shunt point is that 20 years experience of some steel mills show that they have operated satisfactorily without it. Anyone will agree, though, that just because you have operated without something for 20 years is no reason to continue without it.

It is very interesting to note in the above paper the similarity between the power circuitry and the speed-torque curves provided in the proposed standard scheme and our company's scheme. This is also borne out in Table I. There, the number of main contacts, contactor coils, resistance steps, relay coils, relay contacts and auxiliary contacts are all held to a very minimum in our control, and this is the approach of the standardized control circuit.

The standardization of steel mill crane control systems is a very worthwhile subject; and if such a program were to proceed, the steel mill industry itself would have to get together and agree among themselves as to what is the most desirable performance for the hoist, trolley and bridge drives of a steel mill overhead crane.

K. S. Kuka: There is no questions that the subject matter of standardization of steel mill crane control system is a controversial subject and needs extensive, industry-wide discussions.

It is indeed gratifying to note that all the five major crane control manufacturers have given their valuable comments through their control design specialists in the crane line. As the author of the paper I accept the criticisms and comments with a view to carrying on the discussions still further.

It does not seem necessary to reply to each of the criticisms separately and therefore the following general comments are made:

1. The main object of the paper is to present a case for the standardization of the basic crane control circuits, the desirability for which is not questioned by any party interested in the steel industry. The circuits proposed in Figure 9 and Figure 16 are presented as a basis of discussion. It was not intended that these be adopted straightway as an industry-wide standard as the necessity for modifications to improve performance should be self-evident.

2. The object of standardization is definitely not to throttle any future research or development. Such advancements will go forth in spite of any existing standards. In fact, in a progressive technique, the standards are revised from time to time as accepted advancements take place in the technique. As far as the d-c constant potential crane control circuits are concerned, it can be safely taken for granted that the main motor current circuits have reached a stage where future improvements are likely to be in the design of the contactors and relays and in the refinement of the auxiliary control circuits only.

It is possible to define the basic speed-torque curves and standardize on the main current circuit with the sequence of contactors and resistance steps as a preliminary step toward standardization.

Standardization of the main current circuits with definite accelerating steps will be a great gain to the steel mill crane people as the basic circuit will then be well-defined and understood regardless from whom the controller is purchased. Once the main current circuit is fixed, the individual control circuits cannot be very different among different manufacturers because their efforts to incorporate similar operating and safety features under the impetus of competition will definitely tend toward a common circuit. The major advancements will naturally be in the direction of better contactors and relays that give better life expectancy and less contact freezing, burning of the operating coils and mechanical failures.

3. In the paper, the author has proposed certain circuits as reference circuits for standardization. These are presented as the starting points for discussions. The final circuits will naturally evolve once the object of the standardization is accepted, and steps are taken to arrive at acceptable solutions.

4. For crane controls, only two basic electrical circuits are involved; one circuit is for the travel motion, which may be crane long-travel, cross-travel, slew or revolving motions; and the other circuit is for the hoist motion. The characteristics of the circuits are distinct and well defined and can be treated separately.

a. *Travel motions*—In the paper the author has made out a case in favor of the dynamic braking, nonplugging method of control for the travel motions and in Figure 9 a possible arrangement is proposed.

The major criticism has been the problem of graduated dynamic braking because the dynamic braking torque depends on the free running speed of the motor at the time the motor is connected to give the dynamic braking action. At present for crane travel motions reversing plugging circuits are almost universally adopted. The major reason seems to be that the dynamic braking circuits for single motor operations have been electrically complicated because of the necessity of latched type contactors to give dynamic braking action in both directions of d-c series motor rotation.

The advent of the modern silicon rectifier has made it possible to design a reversing, dynamic braking control circuit that is simple. The main circuit can very easily be rearranged to give a graduated dynamic braking action. The author intends to treat this subject in the form of a separate paper at a later date.

For the object of standardization, what is needed is an agreement whether the reversing plugging method or reversing dynamic braking method should be adopted. With the reversing dynamic braking method, the possibility of eliminating the electro-mechanical or hydraulic brake always remains for most normal steel plant cranes that will indeed be a great advantage to the crane maintenance personnel.

In connection with the series brake operation in a dynamic braking circuit, the statement in the paper has been misunderstood. The series brake would apply as soon as the dynamic braking current falls to about 10 per cent of the brake rating. However, the shoes will apply to the fullest extent only when the current falls considerably below 10 per cent. This would mean that the application of the brake will not be sudden but gradual.

b. *Hoist Motion*—In Figure 16 the author has proposed the main current circuit with contactor sequence. This circuit has been thoroughly tested with oscillograms, etc., and has been proved to give the best stabilized speed-torque curves resulting in smooth crane operations. The circuit has been derived after a long study of the major existing controllers. The circuit is described in the 1956 AISE Proceedings p. 142, in a paper titled "A Stabilized D-C Crane Hoist Controller." The circuit is proposed as a standard because it has the most desirable features of each of the existing hoist controls, and at the same time the best speed-torque curves are obtained. The author firmly believes that the speed-torque curves given in Figure 10 should be accepted by all as the most desirable speed-torque characteristics for a steel mill, constant potential d-c crane hoist control.

The author earnestly requests all the manufacturers of the crane controls to critically compare the main circuit proposal in Figure 16 with their own standard circuit. It will be found that the circuit in Figure 16 has many superior features from the viewpoint of speed-torque curves and of current flow, sequence of contacts closing, life of the contacts under current making and breaking in actual service and the effects of contactor and relay failures in service. The auxiliary control circuit can, of course, be based on the design features of the different contactors and relays to meet the requirements of the main-current circuit. Here again it can safely be stated that to meet the requirements of Figure 16 and to incorporate essential safety features of operations, the control circuits will all be basically similar.

5. The impetus for standardization as proposed in the paper, indeed has to come from the steel industry as it is the ultimate user of steel mill cranes. It is hoped that the Association of Iron & Steel Engineers will take the initiative to obtain a consensus of opinion from the steel industry from the engineers who handle traveling cranes. ▲

Coke And By-Products In 1957

by I. E. Madsen

Data and material in this report are based on information or quoted from Mineral Market Report M.M.S. No. 2780 Dated July, 1958

PRODUCTION of oven and beehive coke in the United States in 1957, as reported to the Bureau of Mines, United States Department of the Interior, amounted to 75,950,721 tons, a total exceeded only in 1951 and 1953 but two per cent over 1956. Although the production of coke from both slot-type and beehive ovens failed to establish a new record in 1957, output from slot-type ovens alone reached an all-time high surpassing the previous maximum of 1955 by 276,478 tons. This increase would have been much greater if the production rate in the first six months of 1957 had been maintained throughout the year. A slackening in pig-iron production in the latter part of 1957 had an adverse effect on coke ovens, and the operating rate of slot-type ovens dropped from 95.3 per cent of capacity in January to 74 per cent in December. Beehive-coke plants were affected to a greater extent and production in December was only about one-third the quantity produced in January.

Construction and modernization of coke ovens, coal-and coke-handling facilities, and coal-chemical-recovery equipment continued on a large scale in 1957. Coke producers reported that 560 new ovens with an annual coke capacity of 2,910,200 tons were completed and placed in operation in 1957 and 611 ovens with an annual coke capacity of 3,332,700 tons were under construction on December 31. Probably the most outstanding developments in the coke industry during the year were: (1) the installation of two new hydrogenation-extraction systems for refining crude light oil, and (2) the starting of a second synthetic ammonia plant based on coke-oven gas.

The average value per ton of coal delivered to oven-coke plants reached on all-time high of $9.91 and the $6.25 per ton for coal delivered to beehive ovens was the highest since 1954. Higher mining costs and an increase in freight rates were the major factors in advancing coal costs. Coal miners were given an increase of $0.80 per hour in April under the terms of their contract with the coal-producing companies and freight rates on coal were increased $0.15 per ton on August 26. Some exceptions in freight rates were made on certain movements. Coal charged into coke ovens, including anthracite, totaled 108,409,103 tons valued at $1,061,454,996, increases of two and eight per cent, respectively, over 1956.

Demand for coke, particularly the metallurgical grades, was good during the first half of the year which kept production high. The slackening in activity in the heavy industries during the latter part of the year reduced requirements for metallurgical coke, and stocks of oven coke at producers' plants increased more than 800,000 tons, reaching over 3,100,000 tons. This was the highest year-end inventory of oven coke since 1938.

In spite of the slowdown in blast-furnace operations in the latter part of the year, 68,769,998 tons of coke was shipped to blast-furnace plants, an increase of four per cent over 1956 but one per cent below the record set in 1953. Although the total movement of coke to blast furnaces failed to reach a new peak, the net coke consumed per ton of metal (pig iron and ferro-alloys) continued to drop and was the lowest on record. According to data compiled by the American Iron and Steel Institute, only 1703.6 lb of coke were consumed for each ton of metal produced. This was 15.5 lb less than the quantity used in 1956 and 233.6 lb lower than in 1948. The improvement in fuel efficiency of blast furnaces in the past decade has been one of the notable achievements of the American iron and steel industry. A contributing factor in this outstanding accomplishment was the improvement in coke quality made possible by advancement in blending techniques and preparation methods of coking coal.

In contrast to shipments to blast-furnace plants which increased four per cent over 1956, shipments to each of the other major coke-consuming groups were smaller. The quantity shipped to iron and steel foundries dropped 12 per cent; to producer-gas plants, 35 per cent; to water-gas plants, 34 per cent; for other

TABLE I
Statistical Trends of the Coke Industry in the United States

	1937	1954	1955	1956	1957
Production					
Oven coke, net tons	49,210,748	59,061,442	73,584,214	71,992,242	73,860,692
Beehive coke, net tons	3,164,721	601,054	1,717,612	2,462,022	2,090,029
Total, net tons	52,375,469	59,662,496	75,301,826	74,454,264	75,950,721
Per cent oven coke	94.0	99.1	97.7	96.8	97.2
Stocks of coke, end of year, net tons	2,595,287	2,948,840	1,700,771	2,334,441	3,147,776
Exports, all coke, net tons	526,683	384,377	530,505	655,717	822,244
Imports, all coke, net tons	286,364	115,781	126,342	130,955	117,951
Indicated consumption, all coke, net tons	51,271,929	59,124,768	76,145,732	73,324,094	74,432,093
Furnace coke, net tons	36,751,969	51,973,401	68,171,966	66,311,598	68,769,998
Foundry coke, net tons	2,038,822	2,568,561	3,253,927	2,951,776	2,588,860
Other industrial coke (including producer and water gas), net tons	4,597,894	3,472,132	3,848,674	3,639,131	3,116,438
Domestic coke, net tons	8,107,518	1,266,722	1,126,065	912,436	662,625
Carbonizing equipment					
By-product ovens in existence, end of year	12,718	15,891	16,039	15,923	15,948
Beehive ovens in existence, end of year	12,194	12,216	10,104	9,659	9,519
By-product ovens under construction, end of year	259	490	261	631	611
Cost of coal charged, oven-coke plants average per ton	$3.74	$9.00	$8.84	$9.35	$9.91
Prices of coke:					
Average realization on oven coke sold (merchant sales)					
Furnace coke	$4.34	$13.83	$14.33	$15.70	$16.08
Foundry coke	$8.47	$23.40	$23.75	$26.50	$28.77
Other industrial coke (including water gas)	$6.08	$12.70	$12.96	$14.35	$15.74
Domestic coke	$6.53	$14.83	$15.10	$16.30	$17.12
Yield of by-products per ton of coal charged					
Tar, gal	8.67	8.46	8.13	8.15	8.32
Ammonium sulphate or equivalent, lb	21.84	21.09	20.06	19.28	19.56
Crude light oil, gal	2.86	2.98	2.91	2.92	2.94
Surplus gas sold or used, M cu ft	6.66	6.58	6.58	6.49	6.55
Average gross receipts for by-products, per ton of coke produced					
Crude tar sold and used (exclusive of amount used by producers for own use in refining and topping and exclusive of tar derivatives)	$0.502	$0.923	$0.840	$0.912	$1.070
Ammonia and its compounds	$0.326	$0.605	$0.502	$0.448	$0.409
Crude light oil and its derivatives (including naphthalene)	$0.435	$1.249	$1.200	$1.213	$1.064
Surplus gas sold or used	$1.483	$2.178	$2.120	$2.102	$2.23
Total coal-chemical materials (including breeze)	$2.974	$5.57	$5.62	$5.10	$5.49

industrial purposes, six per cent; and for residential heating, 27 per cent. Coke exported by producers in 1957 was 25 per cent greater than in 1956. On the basis of data reported to the Bureau of Mines by coke-producing companies, 91 per cent of all coke sold and/or used by producers was utilized by blast furnaces, three per cent by iron and steel foundries, one per cent by producer and water-gas plants; three per cent by miscellaneous industrial plants, one per cent by residential heating, and one per cent was exported.

A slight increase in the average yield of the basic coal-chemical materials (ammonia, crude tar, crude light oil, and coke-oven gas) coupled with a record tonnage of coal carbonized in slot-type ovens results in peak production of these chemicals. Ammonia (NH_3 equivalent of all forms) output rose four per cent, crude tar, five per cent; and crude light oil and coke-oven gas, three per cent each. Production of the derivatives from the processing of crude light oil, namely, benzene, toluene, xylene and solvent naphtha by coke-plant operators increased three, two, four and eight per cent, respectively. Production of tar derivatives at coke plants dropped, however, because two companies sold their tar-processing facilities in 1957 to a tar distillery operating independently of the coke ovens and statistics from these two plants were no longer reported to the Bureau of Mines.

Prices of coke increased during the year because of higher manufacturing costs. Prices of most coal chemicals, except for ammonium sulphate, remained about the same. The largest increase was in the price of oven foundry coke which rose $2.27 per ton (nine per cent). The price of crude tar increased eight per cent and averaged $0.13 per gallon. Prices of light-oil derivatives remained about the same during the year, but ammonium sulphate prices dropped for the fourth consecutive year. The price of ammonium sulphate was so low that four coke plants discontinued its production in 1957. The high cost of sulphuric acid and the low market price made it impractical for these plants to continue recovering this material from their coke-oven gas.

The total value of coal carbonized was more than $1,000,000,000. The value of all coal-chemical materials used and sold and coke and breeze produced amounted to $1,818,000,000 or 71 per cent more than the cost of the coal. Coke and breeze supplied 78 per cent of the dollar value of all products, while coal-chemical materials supplied the remainder or 22 per cent. Additional statistics are covered under their particular topics in Tables I, II, III and IV and in the following sections.

PRODUCTION OF COKE

In 1957, the production of by-product coke averaged 202,000 tons daily compared with 197,000 tons in 1956. Production of beehive coke in 1957 averaged 5720 tons per day and well under the 6760 tons produced in beehive units in 1956. Pennsylvania was the most important state and the leader in the production of by-product coke. The other leading states in the order

TABLE II

Salient Statistics of the Coke Industry in the United States in 1957

	By-product	Beehive ovens	Total
Coke produced:			
At merchant plants, net tons	8,685,795	(1)	(1)
At furnace plants, net tons	65,174,897	(1)	(1)
Total, net tons	73,860,692	2,090,029	75,950,721
Screenings or breeze produced, net tons	4,862,594	50,529	4,913,123
Coal charged into ovens, net tons	104,935,965	3,473,138	108,409,103
Average value of coal per ton	$9.91	$6.25	$9.79
Average yield in per cent of total coal charged:			
Coke	70.39	60.18	70.06
Breeze (at plants actually recovering)	4.65	3.27	4.63
Ovens:			
In existence January 1	15,923	9,659	25,582
In existence December 31	15,948	9,519	25,467
Dismantled during year	535	(3)605	1,140
In course of construction December 31	611	18	629
Annual coke capacity December 31, net tons	80,299,400	5,503,200	85,802,600
Coke used by producer:			
In blast furnaces, net tons	63,044,738	(5)	63,044,738
In foundries, net tons	225,377	...	225,377
To make producer gas, net tons	112,928	...	112,928
To make water gas, net tons	516,189	...	516,189
For other purposes, net tons	491,502	...	491,502
Coke sold: (commercial sales)			
For blast furnace use, net tons	4,041,678	(6)1,683,582	(6)5,725,260
For foundry use, net tons	2,333,049	30,434	2,363,483
For manufacture of water gas, net tons	99,409	2,455	101,864
For other industrial use, net tons	1,522,884	371,071	1,893,955
For domestic use, net tons	660,426	2,199	662,625
Disposal of screenings or breeze:			
Used by producers:			
For steam, net tons	2,113,472	...	2,113,472
For sintering iron ore, net tons	637,956	...	637,956
For other purposes, net tons	528,514	...	528,514
Sold, net tons	1,176,734	50,463	1,227,197
Average receipts per ton sold (merchant sales):			
Furnace coke	$16.08	$14.63	$15.68
Foundry coke	$28.77	$17.03	$28.62
Water-gas coke	$18.53	$15.00	$18.45
Other industrial coke	$15.55	$15.75	$15.59
Domestic coke	$17.12	$10.68	$17.10
Screenings or breeze	$7.05	$3.53	$6.90
Stocks on December 31, 1952:			
Furnace coke, net tons	2,569,128	10,591	2,579,719
Foundry coke, net tons	107,378	...	107,378
Domestic and other coke, net tons	460,316	1,363	461,679
Screenings or breeze, net tons	1,346,742	210	1,346,952
By-products produced:			
Tar, gal	873,474,352	...	873,474,352
Ammonium sulphate or equivalent, lb(4)	2,027,449,979	...	2,027,449,979
Gas, M cu ft	1,090,845,870	...	1,090,845,870
Burned in coking process, per cent	34.51	...	34.51
Surplus sold or used, per cent	63.01	...	63.01
Wasted, per cent	2.48	...	2.48
Crude light oil, gal	301,088,346	...	301,088,346
Yield of by-products per ton of coal:			
Tar, gal	8.32	...	8.32
Ammonium sulphate or equivalent, lb(4)	19.56	...	19.56
Gas, M cu ft	10.40	...	10.40
Crude light oil, gal	2.94	...	2.94
Coal used per ton of coke, tons	1.42	1.66	1.43
Value of coke at ovens	$1,352,096,160	$31,191,475	$1,383,287,635
Value of screenings or breeze	$29,633,090	$178,077	$29,811,167
Value of by-products sold:			
Tar sold and used by producer	$104,411,078	...	$104,411,078
Ammonia (sulphate and liquor)(4)	$30,267,479	...	$30,267,479
Gas (surplus)	$164,757,626	...	$164,757,626
Crude light oil and derivatives	$78,559,617	...	$78,559,617
Other coal-chemical materials(2)	$26,678,633	...	$26,678,633
Total value of coke and breeze produced and coal-chemical materials sold and tar used by producer	$1,786,403,683	$31,369,552	$1,817,773,235

(1) Not separately recorded. (2) Naphthalene, tar derivatives, and miscellaneous coal-chemical materials. (3) Includes idle ovens, not expected to go back into production. (4) Includes diammonium phosphate and ammonium thiocyanate. (5) Included with sales of blast furnace coke. (6) Includes small amount used by producers.

of their importance are: Ohio, Indiana, Alabama, New York, West Virginia, Michigan and Maryland. Order was about the same in 1956 except that in 1957 New York just nosed by West Virginia and Maryland displaced Illinois for eighth position. The first five states produced 69.2 per cent of the national production of oven coke, slightly ahead of the 69.0 per cent in 1956. Pennsylvania was also the leading producer of beehive coke in 1957 with a total of 1,617,500 tons, well under the 2,005,590 net tons produced in 1956. Pennsylvania production was 77.3 per cent of the total of 2,090,000 net tons produced by Pennsylvania, Virginia, Kentucky,

TABLE III

Summary of Oven-Coke Operations in the United States in 1957, by States

State	In existence Dec. 31① Plants	Ovens	Coal carbonized, net tons	Yield of coke from coal, per cent	Coke produced, net tons	Value of coke at ovens Total	Per ton
Alabama	7	1,361	8,122,192	72.88	5,919,434	$110,808,402	$18.72
California, Colorado and Utah	4	751	5,147,772	62.45	3,214,807	75,929,139	23.62
Illinois	7	647	4,085,945	71.42	2,918,015	55,453,391	19.00
Indiana	5	2,091	13,402,537	72.78	9,754,559	214,229,291	21.96
Kentucky, Tennessee and Texas	4	380	2,895,310	70.47	2,040,468	32,319,015	15.84
Maryland	1	752	4,759,214	72.09	3,430,863	②	②
Massachusetts	1	108	815,806	67.96	554,398	②	②
Michigan	4	769	4,936,286	75.11	3,707,430	67,391,899	18.18
Minnesota	3	241	1,279,537	71.64	916,713	18,977,175	20.70
New Jersey	2	341	1,326,065	72.96	967,526	②	②
New York	3	831	5,740,590	69.60	3,995,320	65,270,289	16.34
Ohio	15	2,439	16,037,991	70.45	11,299,353	198,611,442	17.58
Pennsylvania	14	4,069	29,213,075	68.75	20,082,883	343,692,212	17.11
West Virginia	5	813	5,679,115	69.34	3,938,002	62,071,263	15.76
Connecticut, Missouri and Wisconsin	3	355	1,494,530	75.00	1,120,921	25,205,930	22.49
Undistributed	..	...	...	...	...	82,136,712	16.58
Total 1957	78	15,948	104,935,965	70.39	73,860,692	$1,352,096,160	$18.31
At merchant plants	22	2,420	12,099,302	71.79	8,685,795	171,754,998	19.77
At furnace plants	56	13,528	92,836,663	70.20	65,174,897	1,180,341,162	18.11
Total 1956	79	15,923	102,248,733	70.41	71,992,242	$1,274,213,780	$17.70

① Excludes plants retired permanently during year. ② Included with "Undistributed" to avoid disclosing individual company figures.

TABLE IV

Summary of Beehive-Coke Operations in the United States in 1957, by States

State	In existence Dec. 31* Plants	Ovens	Coal carbonized net tons	Yield of coke from coal, per cent	Coke produced, net tons	Value of coke at ovens Total	Per ton
Pennsylvania	48	8,036	2,592,783	62.38	1,617,466	$23,324,155	$14.42
Virginia	4	483	378,896	53.57	202,958	3,051,195	15.03
Kentucky, Utah and West Virginia	6	1,000	501,459	53.76	269,605	4,816,125	17.86
Total 1957	58	9,519	3,473,138	60.18	2,090,029	31,191,475	$14.92
Total 1956	62	9,659	4,089,215	60.90	2,490,284	$35,251,941	$14.16

* Excludes plants retired permanently during year.

Utah and West Virginia, and a much smaller share than the 81.3 per cent of the total which Pennsylvania obtained in 1956.

Pennsylvania was the leading producer for all types of coke with 21,700,400 tons or 28.6 per cent of this country's total, and slightly higher than the 28.3 per cent in 1956. Pennsylvania total production was also slightly greater than the 21,103,996 tons produced in 1956, which, like last year, is contrary to the trend for over-all production.

NUMBER AND CAPACITY OF OVENS

At the end of 1957 there was a total of 15,948 by-product ovens in existence which was 25 more than at the beginning of the year. The total annual capacity of all the by-product ovens totaled 80,299,400 tons which was a slight gain over the 79,965,100 tons at the beginning of the year. Some 560 ovens were built in 1957 compared with 302 in 1956. Under construction at the end of the year was a total of 611 ovens. Some 535 ovens were abandoned during the year compared with 418 in 1956.

At the end of 1957 there was a total of 9519 beehive ovens compared with 9659 at the beginning of the year; there were some 605 beehive ovens dismantled during the year compared with 735 in 1956. At the end of the year there were 18 beehive ovens under construction. Total beehive capacity was 5,503,200 net tons compared with 5,765,700 tons at the end of 1956, a drop of about 260,000 tons. Total capacity of beehive and by-product ovens at the end of the year was 85,802,600 tons compared with 85,730,800 tons the previous year or a slight gain of 72,000 net tons.

Of the 9519 beehive ovens, some 8036 are located in Pennsylvania with the remainder being in Virginia, Kentucky, Utah and West Virginia.

Of the 15,948 by-product ovens, the leading state was Pennsylvania with 4069 units, next was Ohio with 2439, and following this was Indiana with 2091, Alabama with 1361 and New York with 831.

COAL CHARGED INTO COKE OVENS

In 1957 coal charged into coke ovens totaled 108,409,103 tons compared with 106,292,116 tons in 1956. Of this, 104,935,965 tons, with a value of $1,039,764,913, were charged into by-product ovens and 3,473,138 tons, valued at $21,690,083, were charged into beehive ovens. The average value per ton of coal charged into

TABLE V

Coal-Chemical Materials, Exclusive of Breeze, Produced at Coke-Oven Installations in the United States in 1957 (1)

Product	Produced	Sold			On hand Dec. 31
		Quantity	Value		
			Total	Average	
Tar, crude, gal	873,474,352	(2) 441,988,878	$ 57,508,917	$ 0.130	33,194,747
Tar derivatives:					
Crude chemical oil, gal	26,216,578	27,238,381	7,229,268	0.265	733,395
Pitch of tar: (3)					
Soft, net tons	599,958	14,578	390,430	26,782	12,843
Medium, net tons	9,092	9,371	382,385	40,805	702
Hard, net tons	315,954	41,054	1,141,649	27,808	3,806
Other tar derivatives (4)	.....	.....	16,929,774	.....	.....
Ammonia:					
Sulphate (5), lb	1,817,805,088	1,939,631,882	24,843,523	0.013	245,230,715
Liquor (NH_3 content), lb	34,682,620	31,645,981	1,058,336	0.033	3,215,656
Diammonium phosphate, lb	75,111,009	79,457,960	4,365,620	0.055	8,483,840
Total	.....	.....	30,267,479	.....	.....
Sulphate equivalent of all forms, lb	2,027,449,979	2,141,844,605	.....	.....	.....
NH_3 equivalent of all forms, lb	522,673,364	552,164,115	.....	.....	.....
Gas:					
Used under boilers, etc., M cu ft	(6) 1,090,845,870	70,672,947	12,912,269	0.183	.....
Used in steel or allied plants, M cu ft		528,492,057	122,200,566	0.231	.....
Distributed through city mains, M cu ft		50,947,967	22,537,537	0.442	.....
Sold for industrial use, M cu ft		37,246,668	7,107,254	0.191	.....
Total	1,090,845,870	687,359,639	164,757,626	0.240	.....
Crude light oil, gal	(7) 301,088,346	14,556,561	3,083,271	0.212	3,972,983
Light oil derivatives:					
Benzene:					
Specification grades (all grades except motor), gal	179,252,295	171,944,225	59,080,169	0.344	12,906,702
Motor grade, gal	1,834,263	1,768,025	281,500	0.159	103,961
Toluene (all grades), gal	37,985,093	37,095,191	10,226,112	0.276	4,371,101
Xylene (all grades), gal	10,793,389	10,358,165	3,204,248	0.309	948,064
Solvent naphtha (crude and refined), gal	6,278,251	6,260,240	1,624,598	0.260	307,395
Other light-oil products, gal	8,115,066	4,472,479	806,373	0.180	284,708
Total, gal	244,258,357	231,898,325	75,223,000	0.324	18,921,931
Intermediate light oil, gal	1,267,369	1,380,425	253,346	0.184	73,267
Sodium phenolate, gal	3,947,894	3,983,524	547,515	0.137	271,248
Sulphur, lb	5,087,220	4,334,820	57,612	0.013	1,553,990
Value of all coal-chemical materials sold	.....	.....	$357,772,272	.....	.....

(1) Includes products of tar distillation conducted by coke-oven operators under same corporate name. (2) Includes 37,164,819 gal sold to affiliated companies for refining. (3) Soft, water-softening point less than 110 F; medium, from 110 to 160 F; hard, over 160 F. (4) Creosote oil, cresols, cresylic acid, crude light tar, naphthalene, phenol, pyridine, red oil, road tar, tar paint and topped tar. (5) Includes ammonium thiocyanate. (6) Includes gas used for heating ovens and gas wasted. (7) 289,437,715 gal refined by coke-oven operators to make derived products shown.

by-product ovens was $9.91 and that charged into beehive ovens was $6.25 with an over-all average of $9.79. These values are appreciably higher than the figures for 1956 which were $9.35, $5.99 and $9.22 respectively. These were some 389,334 net tons of anthracite charged into by-product ovens at an average cost of $10.01 a ton which are included in the previous total. The anthracite cost was $1.15 higher than the previous year.

It took 1.42 tons of coal to carbonize one ton of coke in the by-product ovens which is the same as in 1956. It took 1.66 tons of coal to carbonize one ton of coke in the beehive ovens which is slightly higher than the 1.64 tons in 1956. The cost of coal which was needed to make one ton of coke in the by-product ovens in 1957 was $14.08 a ton compared with $13.30 in 1956; the cost of coal to make one ton of beehive coke was $10.75 compared with $9.85 in 1956.

The leading states in the mining of coal for by-product ovens are, in the order of their importance, West Virginia, Pennsylvania, Kentucky and Alabama who produced 40,445,776, 34,761,847, 13,202,312, and 8,154,072 net tons respectively, or 89.7 per cent of the 107,519,964 tons which were mined.

COKE USAGE AND DISTRIBUTION

Apparent consumption of all coke in the United States in 1957 totaled 74,432,093 tons, slightly over 1,000,000 tons higher than the 73,324,094 tons consumed in 1956. This figure reflects total production in 1957 of 75,950,721 tons, with imports of 117,951 tons, exports of 822,244 tons and an increase in stocks of 814,335 tons.

Blast furnaces used 68,769,998 tons (including 262,450 tons of coke exported for blast furnace use) in 1957, or 90.4 per cent of the 75,950,721 tons produced. This is an increase over the 66,311,598 tons used in 1956. This increase in usage is largely represented by the increase in pig iron production in 1957 which totaled 79,338,932 tons compared with 75,959,560 tons in 1956. There was a slight decrease in the coke rate in 1957 as 1703.6 lb of coke were needed to make a net ton of pig iron and ferro-alloys compared with

1719.1 in 1956. In terms of coal needed to make a net ton of iron the figures are 2430.2 lb in 1957 compared with 2452.4 lb of coal needed in 1956 to make a net ton of pig iron and ferro-alloys. Some 2,588,860 tons of coke were delivered to foundries and this is 3.5 per cent of the total used during the year and under the 2,951,776 tons delivered in 1956. Coke shipped to water gas plants totaled 618,053 tons; to producer gas plants 112,928 tons and to other industrial plants 2,385,457 tons. Shipped for residential heating were 662,625 tons. Comparable figures for 1956 were 939,057; 172,796; 2,527,278 tons, and 912,436 tons respectively. All of these usages were down in 1957 from the comparable figures in 1956. Since the basic iron and steel industry used the bulk of the coke which was produced and since the basic iron and steel industry has most of the producing capacity, the movement of coke follows the industry and as a general rule most of the coke was used near where it was produced. The largest user of coke was Pennsylvania with 20,038,190 tons which was slightly higher than the 20,001,640 tons used in 1956. This is a little over 1,000,000 less than the 21,700,400 tons produced in Pennsylvania. Second largest coke consumer was Ohio with 13,421,319 tons. Ohio was also the second largest coke producer with 11,219,400 tons. Ohio, therefore, imported over 2,000,000 tons of coke. The third largest coke user was Indiana with 7,811,400 tons and since Indiana produced 9,754,600 tons, Indiana exported about 1,900,000 tons, most of it probably just over the line into the Chicago district. Every state in the Union as well as the District of Columbia used some coke. On the other hand, only 22 states produced coke. Except for iron producing areas, coke movements were minor.

STOCKS OF COKE AND COKING COAL

Stock of coke increased during the year and the available stocks on hand at the end of the year totaled 3,148,776 tons, an increase of 814,335 tons over the previous year figure of 2,334,441 tons. Stocks of furnace coke at by-product plants totaled 2,569,128 tons, foundry coke at by-product plants totaled 107,378 tons and residential heating and other coke totaled 460,316 tons. The stocks at beehive plants were minor, totaling 11,954 tons of which 10,591 was blast furnace coke. At the end of the year stocks of breeze totaled 1,346,952 tons of which 1,346,742 tons were at by-product plants and 210 tons were at beehive plants. This compared with a total of 941,046 tons stocked in 1956.

GROSS VALUE AND YIELD OF BY-PRODUCTS

The total gross value of by-products which were sold in 1957 was $357,772,272 which is about five per cent more than the $341,628,908 sold in 1956. In addition, some of the by-products made were used by producers and the total value of the coke chemical materials which were sold and used total $404,674,433. The gross value of the by-products sold was therefore 26.4 per cent of the $1,352,096,160, the value of the coke produced at by-product ovens. An average of $24.20 per ton of by-product coke produced was realized from coke, coke breeze and coke chemical materials. This includes $18.32 for the coke, $0.40 for the breeze and $5.48 for the coke chemical materials. The coal cost per ton of by-product coke was $14.08 a ton compared with $13.28 a ton in 1956. The coal cost per ton of beehive coke was $10.38 in 1957 compared with $9.84 a ton in 1956.

In general the yields for primary coke by-products in 1957 were slightly greater than those in 1956. Compared with 1956, tar yield increased from 8.15 to 8.32 gallons per ton of coal, ammonium sulphate or equivalent increased from 19.28 to 19.56 pounds, crude light oil went up slightly from 2.92 to 2.94 gallons and the surplus gas sold or used changed slightly from the 6.49 M cu ft per ton of coal in 1956 to 6.55 M cu ft in 1957. ▲

1959 AISE

SPRING CONFERENCE

Auspices of Rolling Mill Committee

April 27, 28, 29

Hotel Statler
Buffalo, N. Y.

Analytical methods for determining the economical worth of capital expenditures for new equipment provide management with an objective means for making investment decisions.

measuring the investment worth of Capital Expenditure Proposals

by A. D. Howry,
Maintenance Improvement Engineer, Alan Wood Steel Co., Conshohocken, Pa.

FARSIGHTED judgment is an essential requisite for making wise capital expenditure decisions. Such judgment, to be sound, must be based on an analysis of all the facts, many of them extremely technical and complex. In particular, top management needs an objective means of measuring the economic worth of individual investment proposals in order to have a realistic basis for selecting those that will mean the most to the company's long-range prosperity.

The basic measure of the economic worth of an investment is its ability to produce capital or its power to produce profits. If a proposed project cannot qualify as to potential productivity and is not a necessary replacement for continued operation of existing equipment, it must be dropped. If it is not dropped, it may contribute to overall corporate inefficiency and decay.

If the cost of replacement of equipment were not a controlling factor, frequent replacement of equipment to keep the "operating inferiority" at a minimum would always be justified. But replacements cost money so that performance ceases to be the sole objective. We must choose between more capital costs with less imperfection and less capital costs with more imperfection. With these conflicting magnitudes, both of which are adverse, we must balance the proportions or combinations to develop an "adverse minimum" or a point at which replacement should take place. This point is where the lowest combined average of operating inferiority and capital cost obtainable from the best possible new unit is below the lowest average obtainable from further use of the old equipment.

As a result of correlation and computation of a multitude of reports, studies, justifications and economics submitted for all but the simplest of projects, an objective balance formula has been developed after years of study by the Machinery and Allied Products Institute known as MAPI. This formula is one of the governing methods used in all Alan Wood Steel Co. capital equipment replacement analytical work. The other method used is the "investors' method" or the rate at which money could be borrowed and still break even.

The basic intents of these two formulas are:

The *MAPI* method makes an analytical measurement of the annual cost savings or profit potential of the proposed replacement or project against the capital investment made. It takes into consideration the desired percentage return on the investment, the capital recovery period, and the service life of the equipment.

The investors' method relates the average profit to the average unreturned obligation including interest at the highest rate that could be paid without incurring a final deficit. Both averages are taken over the life span of the equipment.

The combination of these studies forms the complete Capital Equipment Analysis, called the CEA, which shows all pertinent contributing data and the pro-

jected percentage return expected. This analysis forms the basis upon which the Expenditures Planning Committee recommends project authorization.

For a descriptive review of the MAPI method, a paper published in the October, 1954, issue of the *Iron & Steel Engineer* titled "The Economics of Replacement in the Steel Industry" by G. G. Beard, presents a complete and comprehensive story.

All requests for expenditures over a given amount are presented to our Expenditures Planning Committee for classification, development, evaluation and recommendation or rejection as the case may be.

Figure 1 — The capital equipment analysis method developed by the Machinery and Allied Products Institute and known as the MAPI method makes an analytical measurement of the annual cost savings on profit potential of the proposed replacement equipment against the capital investment required. Here it is applied to a proposal for purchase of a new planer to replace an old one. Figure 2 is the detailed computation work sheet for this analysis.

ALAN WOOD STEEL COMPANY — FILE NO. SWG-5

1-25

CAPITAL EQUIPMENT ANALYSIS

1. SUBJECT OF ANALYSIS: Planer for Machine Shop — DEPARTMENT: SWG
2.
3. OPERATING RATE ASSUMED: 100 %.

	PROPOSED EQUIPMENT	EXISTING EQUIPMENT
4.	DESCRIPTION: Gray Planer	DESCRIPTION: 72" Planer
5.	72" x 72" with Duplex Table	
6.	EST. PRIMARY SERVICE LIFE 25 YEARS	PURCH. DATE 1917 MFGR. NO. -
7.	EST. TERMINAL SALVAGE VALUE (X) $ -0-	YEARS OF LIFE TO DATE 38
8.	EST. COST INSTALLED (Y) $ 85,000	INSTALLATION COST $ 4,722
9.	TERMINAL SALVAGE FACTOR X/Y -0- %	DISPOSAL Scrap SALVAGE VALUE $ 0

OPERATING COSTS

	FACTOR	PROPOSED EQUIPMENT	EXISTING EQUIPMENT
10.	DIRECT LABOR-ASSUMED OPERATING RATE	$ 20,508	$ 41,017
11.	INDIRECT LABOR-ASSUMED OPERATING RATE		
12.	EXPENSE DUE TO REJECTIONS		
13.	DOWN TIME		
14.	POWER CONSUMPTION	-	-
15.	TOOLING		
16.	SUPPLIES		
17.	FLOOR SPACE (IF USABLE)		
18.	PROPERTY TAX AND INSURANCE 1/2 of 1%	425	
19.	NORMAL MAINTENANCE		
20.	SPECIAL REPAIRS		
21.	SUB-CONTRACT COSTS		
22.	OTHER ITEMS Additional work done	59,180	72,095
23.			
24.	TOTALS:	B$ 80,113	A$ 113,112
25.			B$ 80,113
26.	NEXT YEAR'S VARIANCE IN OPERATING COST		C$ 32,999
27.	(NEXT YEAR'S CAPITAL COST OF RETAINING EXISTING EQUIPMENT)		
28.	RESTORATIVE REPAIRS $ 12,000 (RESTORATIVE REPAIRS X 6%) YEARS EFFECTIVE 3		D$ 4,240
29.	RESALE, SALVAGE OR CONVERSION VALUE OF EXISTING EQUIPMENT $ ____ X 6 %)		E$
30.	SALVAGE, VALUE LOSS, NEXT YEAR		F$
31.	TOTAL (C. D. E. F.)		G$ 37,239
32.	TOTAL NEXT YEAR'S COST FOR PROPOSED EQUIPMENT 6.7 % INTEREST 6 % = 12.7 % X EST. COST OF INST. $ 85,000		H$ 10,795
33.	FIRST YEAR'S GAIN ( ) OR LOSS (—) THROUGH REPLACING EXISTING EQUIPMENT (G - H) (TAKING INTO ACCOUNT DEPRECIATION, LOSS OF EFFICIENCY AND 6% RETURN ON INVESTMENT) (OR —)		$ 26,444
34.	FIRST YEAR'S GAIN THROUGH REPLACEMENT (AS A PERCENT OF NET CAPITAL COST)		
35.	FIRST YEAR'S GAIN $ 26,444 / COST INSTALLED (LINE 8) $ 85,000 - COST OF RESTORATIVE REPAIRS $ 12,000		= 36.2 %

COMPUTED BY A. D. Howry

DATE

Requests are evaluated and classified as one of the following:

Aggressive capital expenditures for diversification and expansion:

1. To increase capacity of existing production facilities.
2. To produce new products based upon profit forecast.

Optional expenditure on existing facilities for quick return:

1. Through reduction of maintenance and/or operating costs.
2. Through increased production from improvements.

Necessary defensive expenditure such as:

1. Required repairs and/or replacements for continued operation of existing equipment.
2. Insurance items—alternate or duplicate facilities to avoid possible downtime.
3. Unavoidable overhead for administrative, legal, safety or welfare considerations.
4. Expenditures to maintain a market position that might otherwise be lost.

The aggressive expenditures, as the name implies,

Figure 2 — Shown here is the detail computation made for Figure 1.

December 5, 1955

CAPITAL EQUIPMENT ANALYSIS - SWG-5
- Work Sheet -

Purchase of Planer for Machine Shop

Folio		
3	Operating rate assumed 100%	
4	Proposed Equipment EWO 4936 - Gray Planer 72" x 72" with Duplex Table and Variable Voltage Controls	$ 85,000
6	Estimated Service Life - 25 Years	
7	Terminal Salvage Value	-0-
10	Direct Labor - Operation Direct Labor savings are due to the speed of the planer - 10% faster. "Each of the two existing planers are working 20 turns/week. They are manned by three Machinists A and three Machinists B, plus the necessary spellmen make up the 40 turns per week. Taking the Machinists B's hourly rate of $2.465, the savings are:	
	Existing Equipment 40 turns/week x 8 hour/turn x $2.465 x 52 weeks/year -	$ 41,017
	Proposed Equipment with Duplex Table 40 turns/week x 8 hour/turn x $2.465 x 52 weeks/year x 50% -	$ 20,508
18	Property Tax & Insurance 1/2 of 1% of $85,000	$ 425
21	Additional Work Done The outside work that is considered predominantly planer work amounted to $36,047.50 for the six month period 3/1/55 to 9/1/55. Estimated yearly figure would be twice the six month figure or	$ 72,095
	It is estimated that the shop will be able to save 15% of this figure due to the increased planning time available, or	$ 59,180
27	Restorative Repairs The amount of $12,000 has been estimated as a figure for restorative repairs, which would have an effective life of three years.	

is a function of corporate and long-range planning for growth, expansion and diversification. Their justification is the result of an intensive and involved study of the market potentials and projected return on the investment.

All other requested capital expenditures must be carefully screened for classification because of the difficulty of determining where necessity ends and profitability begins. Are they separate and distinct, or are they directly related?

Profitability is the sole reason for operating a business; every decision must be based on this axiom. Because bad judgment can hide behind "necessity," it must, except in rare cases, be discarded as a justification when it cannot be translated into profit. The nonprofit type of expenditure is the overhead burden carried by the profit-making projects.

All factors are carefully reviewed. The percentage of forecast funds assigned to "necessary vs optional" items determines the "bogey" or per cent return required of an expenditure to qualify as an optional or quick-return project. It is this class of expenditures to which the yardstick of our analytical work is applied to determine the economic desirability of undertaking the investment. It permits us to rank the proposal on an economic ladder (of percentage return) that shows its relative worth to our over-all economics.

The CEA analysis summarizes all the relevant data into a single, common denominator or figure. This avoids the necessity for supplementary indexes and is applicable to all types of proposals. This single figure is the first year's gain as a percentage of net capital cost.

In the development of our Capital Equipment Analysis the mechanics of comparative valuation are of prime consideration. This is the MAPI method wherein all factors of operation and maintenance are balanced—the old against the proposed. Factors such as operating labor, tooling, supplies, downtime, power consumption, maintenance, special repairs, etc., form a basis for direct comparison for balance. Other factors such as operating inferiority of the old equipment (evaluated at 2 per cent per year cumulative of original cost) and improvements affecting yield of continuous production lines, speed up of operations involved, etc., are vital contributing factors in the determination of balance. Figure 1 is a typical capital equipment analysis employing the MAPI method of evaluation for investigating the practicality of replacing an old planer with a new one. Figure 2 is the work sheet for Figure 1.

The dollar difference between summation of these factors is the next year's variance in operating cost. To this figure is added:

1. Restorative repairs necessary if old equipment is retained (pro-rated per year for years effective).

Figure 3 — The capital equipment analysis method known as the investors' method relates the average profit to the average unreturned obligation including interest at the highest rate that could be paid without incurring a final deficit. Here it is applied to the planer replacement proposal in Figures 1 and 2.

ALAN WOOD STEEL COMPANY

1-26

FILE NO. SWG-5

CAPITAL EQUIPMENT ANALYSIS

SUBJECT OF ANALYSIS Gray Planer - 72" x 72" DEPARTMENT Machine Shop OPERATING RATE ASSUMED 100 %

INVESTMENT EQUIVALENT

* TIME IN YEARS	APPRO. EXPEND.	SALVAGE VALUE RECOVERED	INVENTORY	EXPEND. AVOIDED WHICH WOULD HAVE BEEN REQ'D.	TOTAL	Rate 27% FACTOR	Rate 27% ZERO TIME	Rate 31% FACTOR	Rate 31% ZERO TIME
1/4 to 0	$(85,000)	-	-	$12,000	(73,000)	1.0345	(75,519)	1.0398	(75,905)

OPERATING RETURN

* (1) TIME IN YEARS	(2) ESTIMATED EARNINGS	(3) DEPRECIATION	(4) TAX ON EARNINGS	(5) TAX SAVINGS DUE TO ALLOWABLE DEPR. (IN YRS. DUE)	(2) (4) (3) TOTAL				
0 to 25	$824,975	$(85,000)			824,975	.1480	122,096	.1290	106,422
			$(412,488)	$42,500	(369,988)	.1130	(41,808)	.0946	(35,001)
							4,769		(4,484)

RATE OF RETURN BY "INVESTORS METHOD" 29.1 %
(RATE AT WHICH MONEY COULD BE BORROWED TO BREAK EVEN)

$$\frac{27 + (31-27)\ 4,769}{9,253} =$$

27 + 2.1 = 29.1

COMPUTED BY _____

DATE _____

* ZERO (0) TIME IS STARTING UP TIME OF PROPOSED EQUIPMENT.

2. Resale, salvage or conversion value of old equipment.

3. Salvage value loss for following year if authorization is denied.

From this total dollar value we subtract the total next year's cost of proposed equipment. In the determination of this next year's cost of proposed equipment, we use the adverse minimum chart developed by MAPI. This chart reduces to graph form the algebraic formula, or acquisition cost, estimated service life, terminal salvage value, etc., to a simple, easy reference in which deviations are negligible. This final

Figure 4 — This is a summary sheet for the planer analysis of Figures 1, 2 and 3.

ALAN WOOD STEEL COMPANY

1-24

FILE NO. SWG-5

EWO 4936

CAPITAL EQUIPMENT ANALYSIS

SUBJECT OF ANALYSIS Gray Planer 72" x 72" DEPARTMENT Machine Shop

OPERATING RATE ASSUMED 100 %

CAPITAL COST

COST OF PROPOSED EQUIPMENT INSTALLED	$ 85,000
SPARES REQUIRED	$ -
INCREASED INVENTORY REQUIRED	$ -
INCREASED BUILDING SPACE REQUIRED	$ -
SUB-TOTAL	$ 85,000
LESS SALVAGE VALUE OF EQUIPMENT DISPLACED	$ -
NET CAPITAL COST	$ 85,000

SALVAGE VALUE OF NEW EQUIPMENT AFTER PRIMARY SERVICE LIFE OF 25 YEARS $ -0-

EARNINGS

1. USING "MACHINERY AND ALLIED PRODUCTS INSTITUTE" METHOD OF COMPUTING:

   FIRST YEAR'S GAIN THROUGH REPLACEMENT $ 26,444

   FIRST YEAR'S GAIN AS A PERCENTAGE OF NET CAPITAL COST. 36.2%

2. USING "INVESTORS METHOD" OF COMPUTING RATE AT WHICH MONEY COULD BE BORROWED TO BREAK EVEN ON THE PROPOSED EXPENDITURE. 29.1%

3. USING "RATE OF RETURN" METHOD OF COMPUTING EARNINGS AFTER 50% TAXES:

   ANNUAL EARNINGS $ 16,500

   ANNUAL EARNINGS AS A PERCENTAGE OF NET CAPITAL COST 19.4%

ALTERNATE TYPES OF EQUIPMENT CONSIDERED AND REASON FOR DISCARDING:

USUAL HAZARDS PERTAINING TO THIS PROPOSAL

IF PROPOSED TYPE EQUIPMENT IS NOT COMMONLY USED FOR THIS APPLICATION, EXPLAIN:

OTHER UNUSUAL HAZARDS:

APPROVED BY _____ DATE _____

CHECKED BY _____

IND. ENGR. _____ DATE _____

ENGR. DEPT. _____ DATE _____

MAINT. DEPT. _____ DATE _____

_____ DATE _____

COMPUTED BY A.D. Howry DATE _____

answer is the first year's dollar gain or loss through replacing existing equipment (taking into account depreciation loss of efficiency and 6 per cent return on the investment).

This dollar value, divided by the estimated cost of installation of the proposed equipment, less necessary restorative repairs if the old equipment is retained, gives the percentage gain value. This is the single determining factor on which the project is evaluated against the available unassigned funds and its contribution to departmental and over-all production and cash flow.

These available funds are determined by management when the capital expenditure budget is prepared for use in the company forecast. The budget includes three classifications of expenditures: aggressive, quick return and defensive. The unassigned funds are those that remain after specific aggressive and long-range projects have been budgeted.

Because idle capital is nonproductive, and project requests showing a high MAPI percentage return can pyramid, a method of cash flow forecast minimizing the nonproductivity of idle funds is necessary. The investors' method of analysis is part of all our CEA evaluations.

As stated before, this method relates the average profit to the average unreturned obligation. It recognizes the expenditures with no return through the construction to service date, the pay-out period, and finally through the productive period to estimated terminal operation.

The computation recognizes:

Investment

1. Appropriation expended.
2. Salvage value recovered.
3. Inventory.
4. Expenditures avoided that otherwise would have been incurred.

Operating returns

1. Time—years of service life.
2. Estimated earnings.
3. Depreciation.
4. Tax on earnings.
5. Tax savings due to allowable depreciation, in years due.

The final answer, in per cent, is the rate at which funds could be borrowed to break even. Figure 3 is a typical CEA analysis using the investors method on the same planer analyzed in Figures 1 and 2. Figure 4 is the summary sheet for Figures 1, 2 and 3.

This is the method used at Alan Wood Steel for capital expenditures control. It has proved its worth in the control and allocation of capital funds and the forecast for the future.

But unless we measure the worth of investments made and prove, after a period of service, that the estimated productivity is there, the effort spent on study, computation and evaluation is lost; and the failure reflects on the efficiency of management. Therefore all managers including the one who initially requests the project, must recognize the fact that they must not only sell the justification, but that they also must ultimately prove the justification.

One year from the service date of the project a request for a follow-up report is made for the office of the operating vice president. This request covers the actual performance of the improvements in their first year's service. Because all information must be factual, this report is carefully reviewed. Deviations and intangibles do not add to productivity and are not tolerated.

An axiom carried on the front page of the minutes of the Expenditures Planning Committee reads as follows: "Management must be conscious of the fact that it is morally dishonest to decide on the basis of opinion those things that can be decided on the basis of fact."

Discussion

PRESENTED BY

C. CLAIR MOULDER, Supervisor Methods Engineering, Lukens Steel Co., Coatesville, Pa.

E. J. MANLEY, Assistant Superintendent Maintenance Shops, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

CLYDE ROBERTS, JR., Chief Engineer, Phoenix Iron & Steel Co., Phoenixville, Pa.

J. M. GRAUBARD, Supervisor, Project Engineering, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

FRED SCHOEN, Chief Engineer Alan Wood Steel Co., Conshohocken, Pa.

H. G. HILL, JR., Berwyn, Pa.

A. D. HOWRY, Maintenance Improvement Engineer, Alan Wood Steel Co., Conshohocken, Pa.

C. Clair Moulder: We use a somewhat similar course of action to evaluate expansion programs and equipment replacement projects. While developing our method we found serious deficiencies in the MAPI method of evaluating equipment replacements as well as expansion programs.

We have tried to obtain, and I think we have, a means of arriving at a single figure indicating net worth to the company in terms of money as well as per cent return on the investment.

I would like to ask the author what difficulties if any, and what experience have they had in analyzing their replacement items as well as expansion programs by this method. Further, does their experience indicate this method can be accurately used for both purposes?

For our particular instance we would like to arrive at a point where we have net worth to the company—net dollars in our pocket. If we use this proposed method which saddles existing equipment with the expense of possible repair of thousands of dollars that is considered a part of the machinery expense, the result does not provide the net worth of the investment. Consequently, the per cent return is incorrect.

A further objectionable item on the proposed equipment analysis is that it does not seem to allow any consideration for improvement in excess of the capacity of the present equipment. In other words, what happens to the sales dollars? How do you evaluate the increased sales potential of a proposed facility that may have an

excess of 20 to 30 per cent more capacity than the proposed equipment?

E. J. Manley: I, too, take exception to the MAPI method. I guess the capital equipment analysis is all right, but I would like to leave that with our industrial engineers and our engineering department for evaluation.

However, I am very much interested in the procurement of maintenance facilities. I have never seen anything formal that will thoroughly justify the procurement of maintenance equipment. We are always in a quandary when we go to fight for and maintain a good complement of machine tools in the set of shops.

In our last budget meeting I prepared some notes for discussion with our general superintendent, his assistant, and the head industrial engineer, and came up with some very practical viewpoints on this subject. I made some notes at that time. The following is from those notes.

"Justification for the purchase of maintenance equipment can be made only by careful analysis of the experience in maintenance by the plants of the corporation over the past twenty years.

"The analysis should be made by responsible supervisors of maintenance shops. The recommendations arrived at by such an analysis should then be weighed by the division superintendent of maintenance in collaboration with the supervisors so as to arrive at definite decisions regarding the type, size, quantity and cost of the equipment thus justified.

"The only guide of value known is to use plant tonnage and equipment comparisons, tempered somewhat by the special work peculiar to the plant making the analysis, for justification of additional equipment.

"There are some instances, although rare, where complete justification can be made on a strict dollar basis. Certainly in these cases, the dollar basis should be used.

"Unfortunately, it is necessary to depend upon the integrity and experience of the supervision making the analysis of their operations to keep maintenance abreast of plant production expansions and technological advances as concern maintenance.

"Certainly, regularly purchasing services outside the plant due to lack of a basic facility (machine tool, furnace, ship space, crane, etc.) are an error. It has been said, 'Get the work done outside, total your costs over a period of a year or years, then thoroughly justify.' To this thinking all that can be said is it provides a good method for maintenance to stay behind and certainly costs the stockholders more money in the long run."

We do have to be strong salesmen to procure a maintenance facility. Fortunately, at Fairless we started with a good complement of machine tools based on experience across the corporation and geared to the tonnage that we would produce. We sold our story on that basis. It is up to us to maintain the good complement of machine tools we now have to keep, as I said before, abreast of the technological advances of the times.

Clyde Roberts, Jr.: Mr. Howry brought out a number of good points. We are always looking for better means of presenting to top management the advisability of making capital expenditures for new facilities or improving our existing facilities.

I would like to know what part of the preparation or analysis of cost are prepared by departments outside Mr. Howry's, such as the maintenance department or the superintendent of the department that made the original request for the expenditure.

J. M. Graubard: I would like to ask the writer whether, you utilize firm bids from vendors or so-called good engineering estimates in your analysis of capital cost of equipment. What is your basis for beginning a program to develop the justification of a project?

Secondly, is the work on the development of the justifications all done in the one department, or do you use the industrial engineering group on standards, and the accounting department on costs? By this, I mean how is the program of justification developed from a manpower standpoint before you know whether the project is justified or not?

Fred Schoen: Mr. Howry has pointed out that our expenditures planning control committee have this statement as part of their creed, "It is morally dishonest to base your decision on opinion rather than facts." Realizing this, I am certain that, as engineers, we recognize that making a cost estimate for a job requires accuracy. If an estimate is badly overrun at the time of installation, the MAPI formula might as well have been thrown out. It is easy to see that if the formula indicates a 30 per cent saving and the installed cost is 25 per cent over the estimate, you do not realize a 30 per cent saving. This means that one year after job completion someone is going to have a tough job justifying the installation.

Secondly, I think one of the things that perhaps Mr. Howry did not bring out as clearly as he might have is that the person preparing facts and figures on what are the savings must answer honestly such questions as the following ones. "What am I going to save?"—"Am I going to lay off a man?"—"Is a man coming off the payroll because I am putting in this new piece of equipment?"—"Am I going to be able to produce 25 per cent more with this piece of equipment; and, as a result, shut down another piece of equipment?" He cannot say, "I hope I can do that." He is going to have to be able to do it. As a result your industrial engineers must be used in these studies. They prepare what is practical in the way of savings on equipment. Unless you have these facts given honestly, all of the work that Mr. Howry is doing is lost. The important thing is that all of these formulas are worthless unless the very best efforts are used in gathering facts.

H. G. Hill, Jr.: I want to emphasize the importance of management looking at the dollar value of what they are doing. I know it is not done. It is not being done any more in business, as a matter of fact, than it is being done in Washington or Harrisburg because we, like our government officials, are not spending our own money. That sounds a little tough, but I think it is the answer. If we could understand that, we would have a starting point.

My interest in this work started about 25 or 30 years ago when I saw how corporations were loosely spending large sums of money, stockholders' money, without paying too much attention to whether their investments were ever going to pay off or how well. It worried me; I began to wonder what effect such spending would

have on our economic system if it continued. It is no better today than thirty years ago. I have seen it at every level of management.

In recent years I have refused to help companies when I am not absolutely convinced that their boards of directors and directors are eager to have capital funds spent properly. When you have top management endorsement, something can be done. Without it, the situation is hopeless.

If top management spends money lavishly, the vice presidents will pick up the same pattern. They, in turn, will influence the spending patterns of the superintendents. This will continue down the organizational ladder to the lowest foreman; everybody thoughtlessly spending money because everybody else is doing the same. Our economic system is suffering, and someday it will come apart if we do not overcome this problem.

The stockholder expects a decent return. He does not ask what is going to be done with his money. You might put it into inventory, but is that going to yield a return? You may even put it in a bank account somewhere for the convenience of the treasurer. Is it going to yield a return? It is the stockholder's money, and he wants a return on it. Of course the easiest thing to do is put it into the plant. This is what we generally think of as a capital expenditure; but, after all, it is not the only use we make of capital funds. Put it in any asset you please; it is still capital. We have to know whether these capital funds are being used profitably.

Management has, throughout industry, set up procedures, authorization systems and all sorts of control. I have seen many of these. I have been asked to build an airtight, foolproof procedure, and I tried very conscientiously to do it. But the longer I work on it, the more I am convinced there is no airtight procedure. For instance, a superintendent will tell me that every time a new procedure comes along he just turns it over to his staff, and in a few hours they will give him three or four ways to beat the procedure and get exactly what is wanted and yet live within the letter of the law.

Of course, the other problem is how top management itself is reacting. They put out procedures, that are always designed to cover relatively small amounts of money. But, when somebody wants something really big, they never talk of authorization for it. The vice president simply goes into the president's office, gives him a quick sales talk, comes out with the money and goes through with the job. This procedure is very common. These companies control small money matters but not large ones; they go through without justification nine-tenths of the time. This is not right. Why is it this way? Top management feels that in order to preserve its prerogatives as such, it must not permit the lower levels to pass on what they want to do. This is why you must have the endorsements of the president and the board of directors as well as the lower management down to the foremen. Everyone must work together.

Industry needs a high rate of return. Most industry takes an average of about 10 per cent, which is about the cost of capital on the market. It is not what you can go to the bank and borrow money for. It has to come from the stockholders. Ten per cent is a fair average over a long span of time for a large number of industries. An individual industry may show 15 per cent but others will be around six or seven per cent for an average of about 10 per cent. Our problem is to make projects earn something like 10 per cent after taxes, overheads, etc. Only then will we be doing a job.

A. D. Howry: Mr. Moulder, asked what difficulty we have had using the MAPI method for replacement analysis of expansion programs. The equipment replacement analysis is very simple. You weigh the proposed against the existing equipment, dollar against dollar and performance against performance. This can be evaluated.

When it comes to expansion programs, we have nothing to balance against. We have no present equipment so we must make a market research study to determine the value of an expansion program, what it would add to our particular industry, and what return to expect. Also, in long range planning you have to evaluate the market potentials against an alternate expenditure such as a diversification of some kind. You must determine which is the most valuable to you, your company, and to your customers.

As to MAPI, or the variation of the MAPI method that we use, we recognize that it is far from complete. It is the best tool that we have been able to develop for our use. We feel that it gives results that are better than the answers we obtained before. Until we find something better, we are going to continue with it and try to improve it.

The evaluation of replacement equipment with increased capacity is relatively easy to resolve as the work factor or units produced per manhour can be directly compared with the known production of the old machine.

Mr. Manley asked whether the industrial engineers check our method. The answer is yes. In our work we get all possible checks. If it is a piece of operating equipment the operating people give us their idea of the justification of it as to how it would fit into their picture and what they expect in return. Our maintenance department is requested to give their picture of the economics of the addition, improvement or new machinery against the old. The industrial engineers make a study of the operating personnel and of production to see how the new machine will fit into the picture. All of these studies are turned over to the capital expenditure analyst. His opinion is unbiased, he evaluates all factors and reduces them to a common denominator that is presented to the expenditure planning committee. This committee has members from all divisions. This committee reviews the entire project and approves or rejects it depending on what the findings are.

Mr. Roberts asked what part of the report is by maintenance and other departments. All have a very definite part in the final report.

Mr. Graubard asked about the capital cost of new equipment and the basis of the cost. Our chief engineer, Fred Schoen, gave a few viewpoints that helped to answer this question. Our engineering department investigates not only the cost of the piece of equipment but the cost of the piece of equipment installed and ready for operation. The figures he used are quoted prices from the manufacturer. They work directly with the manufacturer, developing the economics of the particular unit and what the piece of equipment will do. That all enters the picture. ▲

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, January 26, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Kaldo Rotary Oxygen Converter Steelmaking Process," Part I—T. A. Donegan, Union Carbide Corp., Linde Div., Birmingham, Ala., Part II—T. Olaf Dormsjo, Stora Kopparberg Corp., New York, N. Y., and D. R. Berg, Dravo Corp., Pittsburgh, Pa.

Reich Hotel, Gadsden, Ala.

BUFFALO SECTION

Tuesday, January 13, 1959—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Devices and Techniques of Data Processing and Programming as Applied to Metal Rolling and Processing," by R. M. Sills and G. E. Terwilliger, Systems Application Engineer, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

Sheraton Hotel, 715 Delaware Avenue, Buffalo, N. Y.

CANTON SECTION

Monday, January 19, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Application of Brakes to Motors and Equipment," by J. C. Ponstingl, Supervisor, C. & A. Engineering, Westinghouse Electric Corp., Cleveland, Ohio

Mergus Restaurant, Canton, Ohio

CHICAGO SECTION

Tuesday, January 6, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Russian Steelmaking," by F. M. Rich, General Manager, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

South Shore Country Club, Chicago, Ill.

CLEVELAND SECTION

Tuesday, January 20, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Romance of Metals," by Dr. H. K. Ihrig, Vice President in Charge of Research, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Cleveland Engineering & Scientific Center, 3100 Chester Avenue, Cleveland, Ohio

DETROIT SECTION

Tuesday, January 13, 1959—Dinner 6:30 P.M., Meeting 8:00 P.M.

Ford Steel Division Night

"Pressurizing Coke Ovens During Shutdown," by A. Donald Shattuck, Superintendent, Coke Plant, Blast Furnace Div., Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Detroit, Mich.

Dinner, Cafeteria; Meeting, Auditorium, Central Office Building, Ford Motor Co., Dearborn, Mich.

LOS ANGELES SECTION

Monday, January 12, 1959—Social Hour 6:15 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Details not Available.

Michael's Restaurant, 6309 E. Washington, Los Angeles, Calif.

PHILADELPHIA SECTION

Saturday, January 3, 1959—Dinner 6:00 P.M., Meeting 7:00 P.M.

Old Timers Night

"Closed Circuit Television in the Fairless Works," by R. W. Sheffler, Supervisor, Electrical Engineering, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Pictorial Review of Early American Blast Furnaces," by G. C. Little, Assistant Superintendent, Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

Engineers Club, 1317 Spruce St., Philadelphia, Pa.

PITTSBURGH SECTION

Monday, January 12, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Kaldo Oxygen Steelmaking Process—Its Metallurgy and Economics," by T. Olaf Dormsjo, Stora Kopparberg Corp., New York, N. Y., and D. R. Berg, Dravo Corp., Pittsburgh, Pa.

University Club, Pittsburgh, Pa.

ST. LOUIS SECTION

Wednesday, January 28, 1959—Dinner 6:30 P.M., Plant Trip 7:30 P.M.

Inspection Trip through Dow Chemical Co., Madison, Ill.

Dinner, Dow Chemical Company's Cafeteria, Madison, Ill.

SAN FRANCISCO SECTION

Tuesday, January 20, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Judson Steel Corp. Night

"Steel Making Does Not Have to Pollute," by Benjamin J. Linsky, Director of Bay Area Pollution

Shattuck Hotel, Shattuck & Alston Way, Berkeley, Calif.

UTAH SECTION

Monday, January 12, 1959—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Production Planning for an Integrated Steel Plant," by A. E. Lawrence, Assistant Superintendent Production Planning, Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah.

Grandview Cafe, Provo, Utah.

YOUNGSTOWN SECTION

Monday, January 26, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Handling Industrial Waste," by J. Leonard Hough, Assistant Chief Engineer, Republic Steel Corp., Youngstown, Ohio, and M. H. Morgan, Jr., Assistant Chief Engineer, Ohio Works, United States Steel Corp., Youngstown, Ohio

Mahoning Country Club, Girard, Ohio

STEAM is ordinarily used to atomize liquid fuels for open hearth furnaces. However, steam depresses the maximum flame temperature of the fuel which, in turn, limits the amount of heat theoretically available for transfer to the bath.

Other gases such as air, natural gas, coke-oven and blast furnace gas have been substituted for steam but only with limited success because of supply problems. Jet atomization with the recently developed reaction-type jet burners shows considerable promise. The results of process production tests have shown higher flame temperatures, with a consequent increase in the radiation of heat to the bath, and up to 30 per cent higher firing rates, with excellent flame propagation, for jet atomization compared with steam.

The over-all effect of jet atomization has been an increase in steel production rates resulting in reduced open hearth production costs. The process appears to be of considerable significance to the steel industry.

JET ATOMIZATION

Description of process—Jet atomization is probably the most novel and effective of the several atomization methods that have been proposed as alternatives to steam. In this process the energy required for atomization is provided by the combustion of gas or liquid fuel under pressure. The oxidant may be any gas mixture with an oxygen content equal to or greater than that of air (21 per cent). The combustion takes place in a water-cooled chamber in the rear of the burner. The hot products of combustion are released from this chamber at approximately sonic velocity for atomizing the liquid fuel.

A simplified view of an air-fuel gas jet burner is shown in Figure 1. During operation compressed air and natural or coke-oven gas are delivered to the burner at 50 to 75 psi with heat rates of 3 to 5,000,000 Btu per hr depending upon the main fuel oil flow and on the type of flame desired. Regulation of these flows to the burner, by a single control knob on the instrument panel is the responsibility of the first helper. Furthermore, operation of the jet burner is similar to that of steam burners in that jet burners operate automatically and are incorporated as an integral part of the regular furnace control system as are steam burners. The jet burner has shown no deleterious effect on furnace refractories.

Comparison to steam atomization—Steam is preferably superheated and supplied at 150 to 200 psi in contrast with the 50 to 75-psi supply pressures required for jet atomization. Depending upon the type of flame desired, steam consumption requirements are generally 3 to 6 lb per gal of oil or up to 10 lb per gal of tar or pitch fuel fired.

The use of steam for atomization has significant thermal disadvantages one of which is the decrease of maximum flame temperature with consequent reduction of thermal radiation to the bath or charge. This loss of heat is primarily due to absorption of sensible heat by the steam and to the heat consumed by the chemical dissociation of part of the steam. This dissociation of the steam is the result of its high temperature and carbonaceous atmosphere. However, even though a thermodynamic analysis of the open hearth combustion process indicates the undesirability of using steam, actual experience and the recent Ijmuiden tests show steam to possess, as yet unknown, mechanial advantages which apparently offset, to some degree, its thermal disadvantages.

Both steam and jet burners may be considered as expansion engines performing work on the fuel. The steam burner may be likened to a simple steam engine in which energy is supplied by steam at moderate pressure and low temperature (150 psi and 600 F). In a similar fashion the jet burner may be likened to the modern jet engine in which energy is supplied by its combustion products at a relatively low pressure and high temperature (30 to 50 psi and 3500 to 4000 F). Consequently, the jet burner heats the fuel oil to a temperature as high as 1500 F before burning begins in the furnace compared to a preheat temperature of 250 to 350 F for steam-atomized oil.

A comparison of the effect of varying the amount of atomizing agent used (lb per gal of oil) on the temperature of atomized oil leaving a steam burner and atomized oil leaving a jet burner firing natural gas with air is shown graphically in Figure 2. This graph indicates the jet-atomized oil may reach practical atomization temperatures as high as 1200 to 1300 F (average about 900 F) whereas the steam-atomized oil barely attains a temperature of 350 F. Furthermore, depending on burner design, the momentum and velocity of jet-atomized fuel (due to its higher temperature) can be increased significantly over steam-atomized oil.

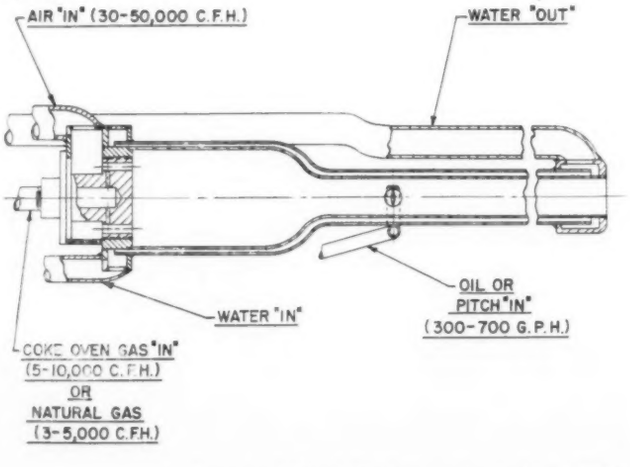
THERMAL CONSIDERATIONS

Critical temperature—The concept of mean critical temperature level or simply critical temperature is important when evaluating the effectiveness of jet or steam atomization in open hearth furnaces (1).* This

* Numbers in parentheses refer to Bibliography at end of paper.

OPEN HEARTH

Figure 1 — This simplified schematic view of an air-fuel jet burner for atomizing open hearth fuel shows its various inlets.



temperature level is the lowest theoretical temperature at which the open hearth process could function. It is very useful when analyzing the thermal aspects of high temperature systems. The critical temperature for open hearth steelmaking depends on several factors. These include the melting points of iron and slag, the depth of bath and the furnace geometry. Normally, about 2800 F is considered the critical temperature in steelmaking. Full consideration of this high-temperature datum level is beneficial because maximum thermal efficiency depends on the generation of the maximum amount of heat per unit of fuel fired at temperature *in excess* of the critical value of 2800 F. This excess heat represents a thermal "driving force" for the system because heat produced at a temperature below the critical cannot be used by the furnace directly. Heat at less than 2800 F comprises most of the heat of the open hearth furnace and should be considered as waste heat insofar as it cannot be used directly by the furnace. It can, though, be partially recovered by regeneration or in waste heat boilers.

The physical character and temperature of the open hearth flame, as well as its final performance, depend largely on the condition of the oil leaving the burner and on the temperature of the preheated air. The degree of atomization, the oil temperature, the chemical composition of the oil and inerts, the velocity and the momentum are also of particular importance. Calculations indicate that 5 lb of steam (150 psi and 600 F) per gal of oil atomized may decrease the flame temperature by about 350 F below the flame temperature of oil not diluted with steam. Furthermore, the corresponding useful heat available to the bath (that quantity of heat available above a critical temperature of 2800 F) may be decreased as much as 9500 Btu per gal of fuel.

In contrast, 5 lb of jet combustion products per gal of oil may decrease the flame temperature only about

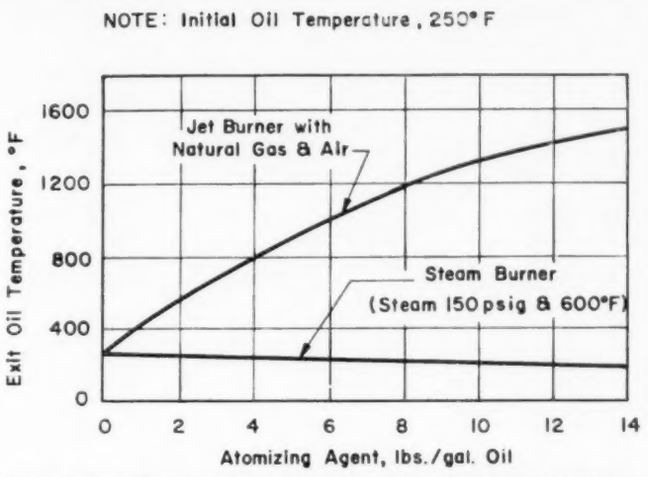


Figure 2 — These two curves show the effect of atomizing agent on the exit temperature of the oil for both jet and steam burners.

75 F and the useful heat only about 500 Btu per gal of oil. The relationship of atomizing agent to theoretical flame temperature and to available high temperature heat are shown in Figures 3 and 4 respectively. It can be concluded from the plotted curves that any atomizing diluent is thermally detrimental, but that the hot gaseous combustion products of the jet burner are far less detrimental than those of steam.

Heat transfer in the open hearth furnace—The effectiveness of jet atomization is related to the general mechanism of heat transfer in the open hearth furnace. In this respect, all the modes of heat flow are present in the open hearth system—conduction, convection transfer within liquids and between gases and liquid or solid surfaces, and radiation from solids, liquids and gases. However, because as much as 80 to 85 per cent of the heat transferred to a flat bath is by thermal radiation

FUEL ATOMIZATION
with a reaction-type jet burner

by A. L. Hodge, Staff Engineer (Metallurgy)
and G. W. Hinds, Development Engineer (Metallurgy)
Development Laboratory, Linde Co., Div. of Union Carbide Corp., Newark, N.J.

. . . . use of the energy of jet burners for atomizing fuel results in higher flame temperature and permits larger firing rates than with steam burners . . . . actual furnace tests show use of jet burners increases production . . . .

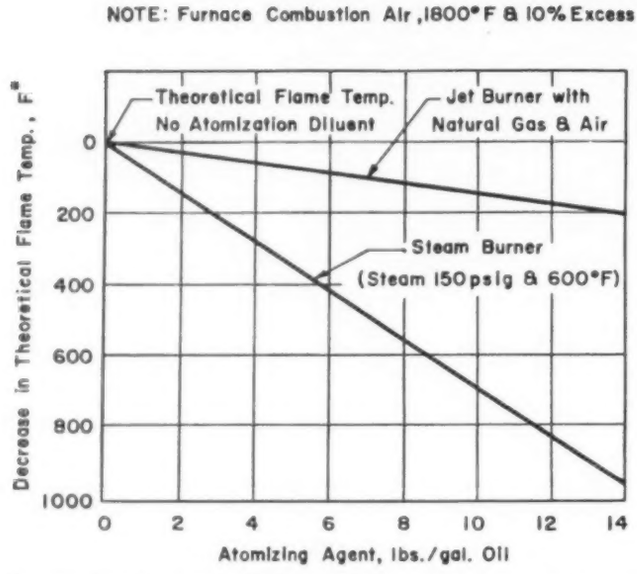


Figure 3 — The reduction of flame temperature by jet and steam burners is shown on this graph.

(2), only this mechanism of heat flow will be discussed.

The mathematical relationship of temperature to radiant heat emitted is expressed by the following modification of the Stefan-Boltzmann Law:

$$H = ek(T_f^4 - T_c^4) \qquad (1)$$

in which:

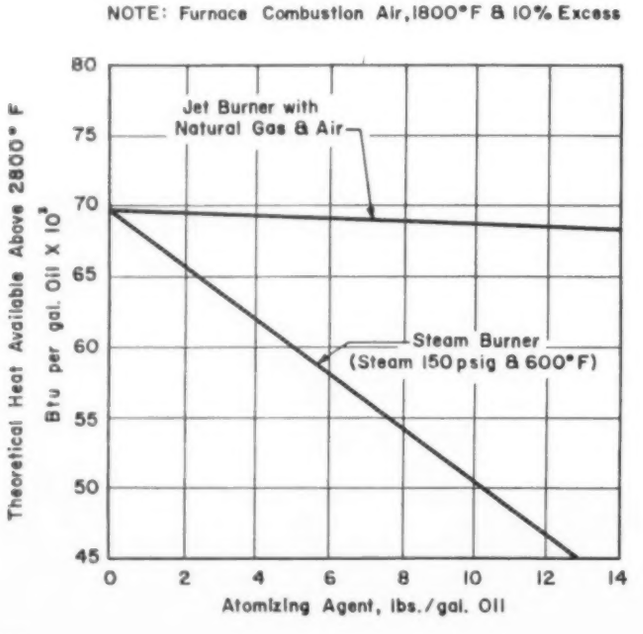
H = heat radiated from a unit region or target area of the flame at temperature T_f to the bath at temperature T_c expressed in Btu per (hr × sq ft)

e = emissivity ≦ 1.0

k = Boltzmann constant = 17.3×10^{-10} Btu per (hr × sq ft × F^4 absolute)

T_f = absolute temperature of flame = F + 460

Figure 4 — The theoretical availability of heat above 2800 F as a function of atomizing is shown for jet and steam burners.



T_c = the critical absolute temperature = F + 460 = 2800 + 460 = 3260

$(T_f - T_c)$ = thermal "driving force" for heat flow from flame to melt.

The above equation indicates that larger thermal "driving forces" result from higher flame temperatures, (T_f), compared to the critical temperature (T_c). Further, the greater the thermal "driving force" and emissivity, the more efficient the process is thermally.

Assuming, for example, a flame temperature of 3400 F for steam-atomized oil, a flame temperature of 3500 F for jet-atomized oil and equal emissivity for both cases, the following conditions would exist:

a. Theoretical flame temperature (T_{fs}) of steam-atomized oil = 3400 F + 460 = 3860 F absolute
b. Theoretical flame temperature T_{fj} of jet-atomized oil = 3500 F + 460 = 3960 F absolute
c. Critical temperature T_c = 2800 F + 460 = 3260 F absolute
d. Emissivity for all cases = 1.0
e. Relative heat radiated with steam flame = H_s
f. Relative heat radiated with jet flame = H_j

Then from Equation 1:

$$\frac{H_j}{H_s} = \frac{ek(T_{fj}^4 - T_c^4)}{ek(T_{fs}^4 - T_c^4)} \qquad (2)$$

Simplifying and substituting in Equation 1:

$$\frac{H_j}{H_s} = \frac{(3960)^4 - (3260)^4}{(3860)^4 - (3260)^4} = 1.22 \qquad (3)$$

From the above it is apparent that by increasing the flame temperature from 3400 to 3500 F (a 3 per cent increase) the high temperature heat transferred by radiation is increased by 22 per cent. Considering this relationship with respect to the decrease in the theoretical flame temperatures shown in Figure 3, the jet atomizing burner can be expected to show a definite improvement in thermal radiation over steam atomization.

A thorough explanation of the emissivity factor (e) in Equation 1 is lengthy and beyond the scope of this paper. However, some understanding of this factor is necessary. The emissivity factor defines the physical ability of a body to radiate or reflect heat. In regard to flames, it may be considered a relative measure of their luminosity. The perfect radiator (absorber) or "black body," would have an emissivity of 1.0 while a perfect reflector (zero radiator) would have an emissivity of 0.

The emissivity of open hearth flames is important and varies quit appreciably for different types of flames. For example, nonluminous flames such as coke-oven gas may have an emissivity of 0.2 to 0.3. Highly luminous oil or pitch flames may have emissivities as high as 0.9 in their most dense and opaque region decreasing to about 0.3 in their nonluminous portions. In the above example that compares a 3400 F steam-oil flame with a 3500 F jet-oil flame, the emissivities were assumed constant and equal. However, in numerous laboratory and plant tests made on the jet burner, there are indications that the jet-atomized oil flame had a significantly higher emissivity than the flame produced by steam-atomized oil. This difference is attributed primarily to some pyrolysis and polymerization of the heavier hydrocarbon fractions formed in the mechanism of jet atomization (3, 4).

OPEN HEARTH TESTS WITH THE JET BURNER

Radiation measurements—While investigating the performance of the jet-atomizing burner as compared with steam burners at three different open hearth plants, thermal radiation measurements were made with a radiation receiver and an electronic strip-chart recorder. The radiation receiver consisted of a ten-junction thermopile with a fluorite lens, capable of about 95 per cent response throughout the electro-magnetic spectrum from 0.2 to 10 microns. This range of wave lengths encompasses essentially all the important furnace and flame radiation including the invisible (infrared) radiation bends emitted by carbon dioxide, water vapor and solid carbon. This type of instrument has the advantage of avoiding the erroneously high results obtained by ordinary optical pyrometers when sighted at high intensity narrow band brightnesses such as chemiluminescence or monochromatic radiation. The recorder had a chart speed of 40 in. per hr with a pen speed of about five sec for full-scale deflection.

Radiation measurements in the furnace were made while the bath was clear, about one or two hr before tapping (5). Measurements were taken first at the door nearest the firing end about two min after reversal. The receiver was sighted through the wicket, and the flame was slowly traversed from the slag surface to an elevation angle of 50 to 60 degrees or until a maximum intensity had been reached as indicated by the recorder. The same procedure was used at the other four doors in order, proceeding toward the door farthest from the firing end of the furnace. Measurements were taken at all five doors during each reversal until tap or until the results were consistent. In addition to measuring the total radiation of the flame and backwall, measurements were also made periodically of the backwall radiation within two to three sec after the flame was extinguished during reversal.

It is theorized that, for maximum furnace efficiency and production, as much fuel should be fired as can be completely burned by the fourth or fifth door away from the burner and as much as good refractory practice will permit (6). Under this condition the flame should be characterized by radiation intensity, that is: (1) very high at the first door, (2) rapidly decreasing between the second and third doors, (3) leveling off between the fourth and fifth doors, and (4) exhausting to a minimum value at the fifth door. Thus, a maximum high temperature heat will be liberated from a maximum amount of fuel to the melt, and a minimum will be carried to the regenerators. This would also infer that maximum furnace temperatures are maintained throughout the system at all times.

Figure 5 — These curves show the thermal radiation measurement as made at the different furnace doors using various firing rates with jet and steam burners.

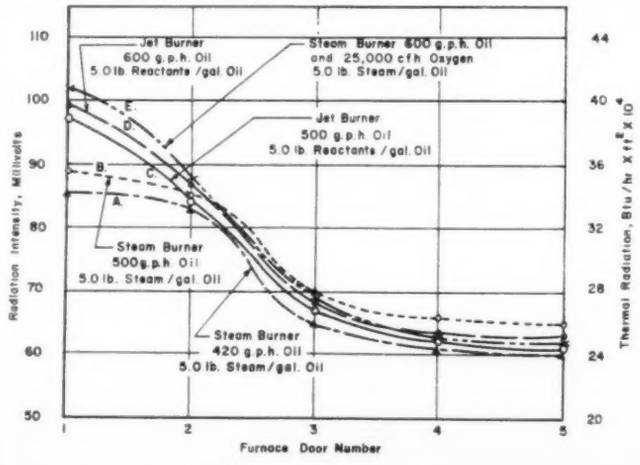


TABLE I
Combinations of Fuel-Oxidant jet Reactants and Atomized Fuel Subjected to Thermal Radiation Measurement Tests

Jet reactants		Liquid fuel atomized
Fuel	Oxidation, per cent	
No. 6 fuel oil	45 O_2 (balance N_2)	No. 6 fuel oil
Coke-oven gas	45 O_2 (balance N_2)	No. 6 fuel oil
Coke-oven gas	45 O_2 (balance N_2)	Pitch
Coke-oven gas	Air	Pitch
Natural gas	99+ O_2 (balance N_2)	No. 6 fuel oil
Natural gas	45 O_2 (balance N_2)	No. 6 fuel oil
Natural gas	Air	No. 6 fuel oil

The total radiation values thus obtained could be plotted directly as millivolts for each door, or the measured emf could be converted to equivalent radiated heat intensity according to the equation, $H = 4020\ R$ (derived in Appendix A), where H is the radiated heat intensity [Btu per (hour × sq ft of target area)] and R is the radiation receiver heat output (millivolts). Typical radiation curves, as shown in Figure 5, were constructed for flames in the same furnace under five different conditions using steam with and without oxygen and using jet atomization. With particular reference to Figure 5 results were as follows with five lb of steam and the same weight of jet-reaction combustion products per gallon of fuel fired:

1. The 200-ton furnace investigated could burn only about 420 gphr of oil efficiently with steam atomization. Curve A shows the flame radiation for this firing rate and indicates relatively complete combustion at the fifth door.

2. Curve B shows that, when an attempt was made to increase the firing rate to 500 gphr, radiation intensity increased slightly in all doors (particularly at No. 5), indicating that burning was still progressing at the outgoing end. This is a very undesirable condition because a substantial waste of fuel in the high temperature zone results as well as a probable melting of refractories in the outgoing end of the furnace and in the regenerators.

3. With jet-atomizing burners (operating on 31,700 cfhr of air and 3200 cfhr of natural gas) in the same furnace, no difficulty was experienced in burning 500 gphr of oil. The radiation as shown by curve C was much higher at the first door and exhausted at a desirably low value at the fifth door. Thus its flame was superior to any obtained with steam atomization at this firing rate.

4. Curve D shows that with jet atomization (38,000 cfhr air and 3800 cfhr natural gas), as much as 600 gphr or more of oil can be fired efficiently with excellent flame propagation.

5. Curve E shows typical steam firing of 600 gphr of oil with 25,000 cfhr of oxygen.

In addition to the tests described above, additional tests were conducted with the different combinations of

TABLE II
Production Data Comparing Steam, Steam With Combustion Oxygen and Jet Atomization in a 200-Ton Open Hearth Furnace

	Steam	Jet	Steam plus oxygen
Total number of consecutive heats	141	171	171
Total production, net ingot tons	28,675	35,055	34,884
Average heat size, tons	203	205	204
Average heat time, charge-tap, hr	10.24	9.57	9.33
Average production rate, charge-tap, tons per hr	19.82	21.43	21.86
Average heat time, tap-to-tap, hr	11.78	10.92	10.88
Average production rate, tap-to-tap, tons per hr	17.23	18.78	18.75
Fuel consumption, Btu 10^6 per ton	3.16	2.84	2.99
Oxygen consumption, cu ft per ton	...	...	350

fuels and oxidants as tabulated in Table I. These tests involved many variations in furnace operation. Test results yielded measurements similar to those shown in Figure 5.

Jet atomization has been tested on an experimental basis in three different open hearth plants. During these tests, production in furnaces equipped with jet burners has shown an 8 to 12 per cent increase over furnaces utilizing steam atomization. Test results are shown in Table II. Figures 6 and 7 show cumulative and cell frequency curves for the various production rates obtained with steam, steam with combustion oxygen, and jet atomization. The cumulative frequency for a given production rate is the percentage of the total number of heats that yielded production rates *less* than that given production rate. For these curves, a cell is one of the production rate ranges shown on the abscissas, such as 8.0 to 9.9 tons per hr. The cell frequency for a given cell is the percentage of the total number of heats that yielded production rates in that given cell. Several interesting comparisons can be made on the basis of these curves:

1. From Figure 6 it is apparent that a charge-to-tap production rate of 21.25 tons per hr or more was achieved in 50 per cent of the jet heats, 60 per cent of the steam with oxygen heats and in only 22 per cent of the steam heats.

2. A charge-to-tap production rate of 23.90 tons per hour or more was reached in only 4 per cent of the steam heats, and in 33 per cent of the steam with oxygen heats. In 22 per cent of the jet heats this rate was reached or exceeded.

3. As shown in Figure 7 production at a tap-to-tap rate of 18.95 tons per hr or more was possible in only 30 per cent of the steam heats and in 54 per cent of the steam with oxygen. This rate was reached or surpassed in 45 per cent of the jet heats.

4. At least 16 per cent of the jet heats as compared with four per cent of the steam heats, and 24 per cent of the steam plus oxygen heats, were produced at the tap-to-tap rate of 21.9 tons per hr or more. (Similar data from 150 to 200 jet heat tests in other plants revealed the same encouraging performance.)

Open hearth production rates quite obviously depend on many factors beside thermal efficiency. These include raw materials, charging rates, end products, furnace design and operating practices. Viewed against this back-

Figure 6 — Shown here are curves for charge-to-tap production rates vs frequency distribution for open hearth tests made with steam burners, jet burners and steam burner with combustion oxygen.

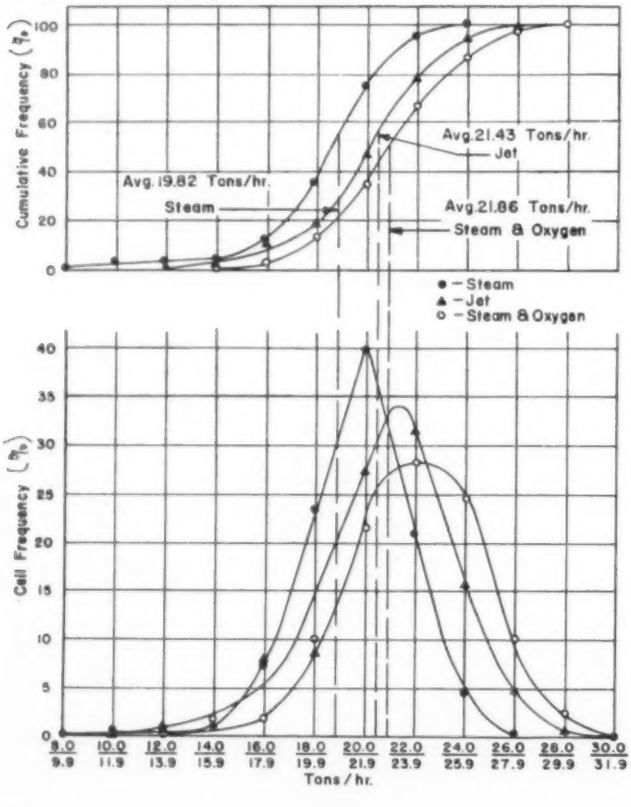
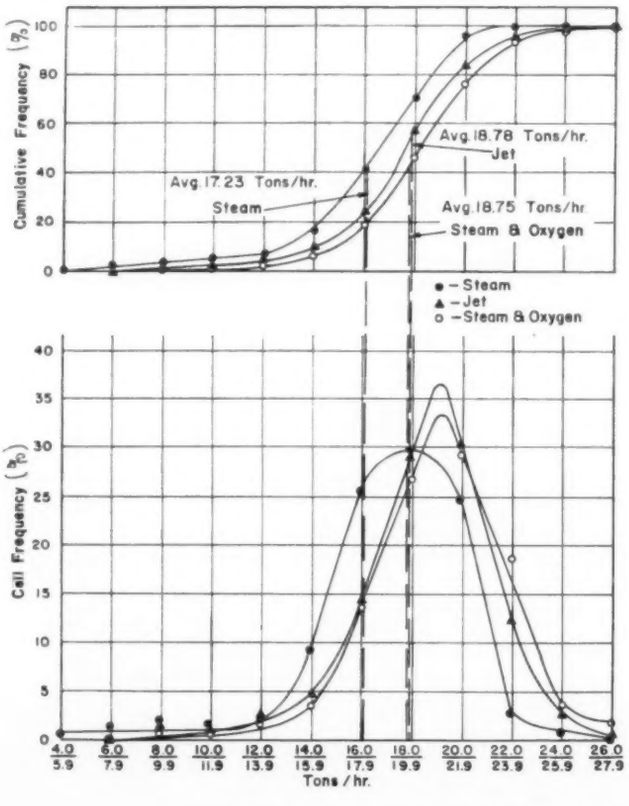


Figure 7 — Shown here are the curves for tap-to-tap production rates vs frequency distribution for steam burners, jet burners and steam burners with combustion oxygen.



ground of factors, jet-burner performances have been particularly encouraging. Although the practicability of jet atomization has been assured, further development work is continuing, particularly in the use of higher energy rates and pressures in the jet chamber. The results of this work should prove interesting in that past tests were conducted with limited-capacity compressors.

SUMMARY

Findings presented in this paper demonstrate that the utilization of energy from the jet reaction flame to atomize liquid fuels in open hearth furnaces is both practical and economical. Jet atomization reduces the amount of heat theoretically available in liquid fuels by only 500 Btu per gal of oil. By comparison, steam atomization reduces heat available to the bath by 9500 Btu per gal of oil. Jet atomization results in more efficient liberation of heat to the charge as indicated by thermal radiation measurements, an excellent guide for evaluating flame propagation and combustion kinetics.

Based on actual furnace tests, jet atomization results in firing rate increases up to 30 per cent and production rate increases ranging from 8 to 12 per cent. Production rates with air-natural gas jet atomization are only slightly less than those obtained when 20,000 to 25,000 cfhr of combustion oxygen (350 cu ft per ton of steel) is used with steam-atomized oil.

ACKNOWLEDGMENTS

The open hearth production tests described in this paper were carried out in three locations: Lukens Steel Co., Coatesville, Pa.; Wheeling Steel Co., Steubenville, Ohio; Youngstown Sheet and Tube Co., Campbell Works, Youngstown, Ohio. The authors wish to acknowledge the generous co-operation of these companies and the very able assistance given by plant personnel during these tests.

BIBLIOGRAPHY

1. Basic Open-Hearth Steelmaking, AIME, New York, 1951.

2. M. W. Thring, Journal of the Iron and Steel Institute, The Iron and Steel Institute, London, Vol. 178, 1954, pp 165–169.

3. "Process for Treating Mineral Oils," by E. W. Rembert, U. S. Patent No. 2,090,766, August 24, 1937.

4. "Flames—Their Structure, Radiation and Temperature," by A. G. Gaydon and H. G. Wolfhard, Chapman and Hall, Ltd., London, 1953.

5. "Measurement and Control of Open Hearth Flame Radiation Intensity at Gary Steel Works," by A. L. Hodge, AIME Open-Hearth Proceedings, Vol. 28, 1945, pp 322–327.

6. "Tonnage Oxygen," by F. J. Clark and J. L. Harrison, Journal of the Iron and Steel Institute, Vol. 186, July, 1957, pp 305–323.

APPENDIX A

Relationship of Measured Thermal Radiation Intensity Expressed in Millivolts and Equivalent Heat Radiated

To derive the relationship of radiated heat intensity to radiation receiver output:

$$H = f(R) \qquad (1a)$$

in which:

H = heat radiated per unit of target area above ambient temperature in Btu per (hr × sq ft)

f(R) = function or relationship of R expressed as millivolt output of radiation receiver

Equation for calibration of millivolt output and temperature:

$$R = ek_1T^4 \qquad (2a)$$

in which:

R = radiation output in millivolts

e = emissivity factor which has a value between 0 and 1.0

k_1 = constant for radiation receiver = 4.310×10^{-13}

T = temperature absolute = F + 460

Relationship of heat radiated, temperature and emissivity from the Stefan-Boltzmann Law:

$$H = ek_2T^4 \qquad (3a)$$

in which:

k_2 = Stefan-Boltzmann Constant = 17.3×10^{-10} Btu per ($ft^2 \times hr \times T^4$)

Solving equation (2a) for T^4:

$$T^4 = \frac{R}{e\ (4.310 \times 10^{-13})} \qquad (4a)$$

and substituing T^4 in Equation (3a)

$$H = e(17.3 \times 10^{-10}) \left(\frac{R}{e\ (4.31 \times 10^{-13})} \right) \qquad (5a)$$

and simplifying:

$$H = \frac{17.3 \times 10^{-10}}{4.31 \times 10^{-13}} R$$

or

$$H = 4020\ R \qquad (6a)$$

For radiant heat transferred above a critical temperature, T_c

$$H_{> T_c} = e\ (17.3 \times 10^{-10})\ (T^4 - T_c^4)$$

Substituting T^4 from Equation (4a)

$$H_{> T_c} = e \left[(17.3 \times 10^{-10}) \frac{R}{e\ (4.31 \times 10^{-13})} \right] - e\ (17.3 \times 10^{-10})\ T_c^4 \qquad (8a)$$

and simplifying:

$$H_{> T_c} = 4020R - e(17.3 \times 10^{-10})\ T_c^4$$

When critical temperature T_c = 2800 F + 460, and e = 1.0

$$H_{>2800\ F} = 4020R - (17.3 \times 10^{-10}) \times 3260^4$$

or

$$H_{>2800\ F} = 4020R - 195{,}500$$

Discussion

PRESENTED BY

L. C. PESKIN, President,
Thermal Research and Engineering Corp.,
Conshohocken, Pa.

G. W. HINDS, Development Engineer
(Metallurgy), Development Laboratory,
Linde Co., Div. of Union Carbide Corp.,
Newark, N. J.

D. C. HANEY, Assistant Superintendent,
Fuel and Power Dept., Youngstown District,
Youngstown Sheet and Tube Co., Youngstown, Ohio

NORMAN DAVIES, President and General Manager,
The North American Manufacturing Co.,
Cleveland, Ohio

IVAN AKEY, Superintendent of Construction,
Great Lakes Steel Corp.,
Div. of National Steel Corp.,
Detroit, Mich.

A. L. HODGE, Staff Engineer
(Metallurgy), Development Laboratory,
Linde Co., Div. of Union Carbide Corp.,
Newark, N. J.

L. C. Peskin: Having been associated for some time with high velocity combustion systems, we have had a number of opportunities to observe the thermodynamic and aerodynamic power inherent in the flow of gases of this type. It might be of some interest to point out that the current methods evolved by the military for producing fogs for screening purposes are based on principles such as those used by the authors. Of course, in the military application, the injected fog oil is handled in such a manner as to avoid subsequent flaming, but atomization and vaporization are carried out in a hot gas stream.

I might also point out that such high velocity, hot gas streams are being used to transport solid particles over considerable distances in which heat transfer to the particles as well as transport is desired. This brings to mind the possibilities of utilizing such a scheme for handling fuel mixtures where a combination of liquid hydrocarbon and solid carbon may be desired for fuel purposes.

I would like to ask the authors whether it is necessary, for good results, to achieve sonic velocity of the reactants at the point of injection into the liquid fuel. At the temperatures involved, such velocities require relatively high air supply pressures for the atomizing burner—compressed air is not the most inexpensive fluid.

Also, it would be interesting to know more about the fuel-air ratios used in the atomizing burner. Our own experience in other applications of techniques similar to this has shown that the chemical composition of the products of combustion may have some interesting effects on the materials being injected in addition to the mechanical effects of atomizing and transporting. No doubt, tests of this nature were performed, and it would be interesting to note what observations were made.

G. W. Hinds: Your first question had to do with sonic velocity at the point of oil injection. We have not carried on any experiments to find the actual velocity at the point of oil injection. Calculated velocities do show 1000 to 1200 fps at that point. We expect, in the near future, to run tests with pitot tubes at that point.

Your second question had to do with the fuel-air ratio used in the burner. Stoichiometric ratio has been the goal because proper combustion in the burner requires a stoichiometric ratio of approximately ten-to-one. Our primary difficulty is controlling the burner to maintain that stoichiometric ratio. If it were outside the range of seven-to-one or 15:1 air-to-gas ratio, it would cause the flame to go out. So we have attempted, in our work, to maintain the ten-to-one ratio.

D. C. Haney: The Youngstown Sheet & Tube Co. began experiments with the fuel-fired jet atomizing fuel oil burner on January 31, 1956. The author's company suggested it as a possibility for improving combustion in the open hearth furnace—they had done the research and development work. The results to date have been surprisingly good and particularly enlightening.

The first set of fuel-fired jet-atomizing oil burners was installed on No. 6 open hearth furnace at Campbell Works on January 31, 1956. These burners had to be taken out of service immediately because of the instability of the jet flame.

Engineers worked on this problem in the laboratory and in our plant, but it was mid-March, 1956, before changes in burners, piping and control reached a point where the burners, although not reliable, could be kept in the furnace more or less continuously. Men worked on a round-the-clock basis to observe and make necessary adjustments. Without such attention it would not have been practical to keep these burners in the furnace. The jet burner was used on 121 heats out of a total of 173 heats for the furnace campaign ending in May, 1956. Plant experiments were then discontinued pending further laboratory research.

This work was successful. Experiments on No. 6 open hearth furnace were resumed in the latter part of November, 1956, with new burners and a change in the automatic control system and auxiliary equipment. Since then the fuel-fired jet atomizers have not given any ignition trouble nor have they required any special attention.

Some trouble was also had at the start with plugging caused by the caking of fuel oil in the supply line to the burner. This was corrected by pulling the oil entry point away from the burner tip. It is no longer a source of trouble.

Water was also a major problem. The better than 3000 F in the combustion chamber of the jet atomizer requires particular cooling. River water was used initially. This had to be given up because acid corrosion resulted in burn-outs. Chemically treated, filtered water has since been used with success.

The air compressor and its accessory equipment and controls have required no maintenance beyond that normally required where equipment of this type is kept in continuous operation.

The fuel-fired jet atomizing burner is operated substantially the same as the steam atomizing oil burner in the sense that the operator is required to make only one adjustment for varying the quantity of atomizing agent. In this case he sets the flow of natural gas to the jet atomizer, and the required air for combustion of this gas is simultaneously supplied by mechanically linked-in-tandem, similarly characterized port valves. Separate control valves are provided for each end of the fur-

nace, and these also serve as reversing valves.

The jet atomizers on the present burners are operating on a maximum of 3300 standard cu ft per hr of natural gas at 35 psi and 35,000 standard cu ft per hr of air at 45 psi. About 600 gal of fuel oil at 45 psi are atomized per hour. This amounts to about 4.5 lb of atomizing agent per gal of oil. Natural gas is used at maximum line pressure. The air compressor is operating at its capacity.

The jet atomizer is never completely shut off. When a fuel oil reversal valve closes, the natural gas-air valve to the jet atomizer serving the same end of the furnace goes to a minimum position. Under this condition the natural gas is reduced to 300 cfhr and the air to about 1000 cfhr. In addition about 300 cfhr of straight oxygen are automatically bled into the air supply to provide stability for the pilot-igniter flame.

About 3600 gal of water per burner or 7200 gal per furnace per hr at 22 psi are required for burner cooling. Good quality water is necessary for cooling this burner because of the better than 3000 F temperature which prevails in the jet atomizer combustion chamber.

In the final analysis, performance must be evaluated on the basis of production. Experience to date indicates that the No. 6 furnace with the fuel-fired jet burners is capable of producing 209 net ton heats at an average rate of 18.7 net ton per hr, tap-to-tap. This is about 1.0 net ton per hr more than that obtained under the same operating conditions with steam atomizing oil burners without combustion oxygen. It amounts to about 1.0 net ton per hr less than that experienced with steam atomizing burners using 375 cu ft of combustion oxygen per net ton.

The better production with the fuel-fired jet atomizing burners compared with that for the steam atomizing burners without combustion oxygen is credited to two things. First, better atomization and increased burner energy and momentum have made it possible to increase the fuel oil firing rate from 480 to about 600 gphr. Second, greatly increased flame radiation has provided a hotter over-all furnace.

The even greater production rate obtained when using steam atomizing burners and combustion oxygen during melt-down over that obtained with the jet atomizing burners is explained by a still hotter and sharper flame that is conducive to faster melting.

The engineers have suggested that production with the fuel-fired jet atomizing burners could be further increased by raising the pressure and quantity of natural gas and air to the jet atomizer to increase the oil mixture temperature and burner momentum. The present equipment can only deliver enough natural gas and air to provide a maximum of about 4.5 lb of atomizing agent per gal of fuel oil when firing at a rate of 600 gphr. Equipment capable of providing 60,000 cu ft of air and 5500 cu ft of gas at pressures up to 75 psi is being loaned to us and will be installed shortly. This will make it possible to increase the atomizing reactants to as much as 7.7 lb per gal of fuel oil when firing 600 gal per hr.

The question naturally arises as to whether the same increase in production could be accomplished more simply and economically by other means such as increasing the pressure, flow and possibly the temperature of atomizing steam. The comparative production rates cited above were obtained with atomizing steam available to the burners at only 130 psi and 500 F. Under this condition it was possible to properly burn only about 480 gphr of oil. The addition of combustion oxygen raised the potential to 600 gphr. In both cases the atomizing steam amounted to less than 4.0 lb per gal of oil. Steam at 250 psi at the burner has just been made available for atomization. This makes it possible to raise the atomizing agent reactants to better than 6.5 lb per gal during melt-down. There is now no difficulty in burning 600 gphr of oil without combustion oxygen. Melt-down has been speeded up appreciably. It is too early to cite figures.

In conclusion, experience with the fuel-fired jet burner has demonstrated the possibilities for improving combustion and thereby increasing open hearth production by improving burner performance. We agree with the authors that this particular burner appears to have inherent advantages over steam atomizing burners. However, this can only be substantiated by continuing the investigation.

Norman Davies: I thought I saw a comparison in which two variables were introduced. One was a particular kind of atomization that appeared to be quite intering. Another was the use of air in place of steam. Has there been any work done to compare just the results of air and steam without regard for the novel way of atomizing the oil?

Member: What are the physical dimensions of this burner for the flows that the author has described?

Ivan Akey: A good comment concerning increased flame temperature and radiation from the flame was made. Do you have any results on roof life with respect to that? Also, what are your thoughts with respect to the exit end of the furnace, the checkers?

A. L. Hodge: Mr. Peskin's question regarding momentum is very important. We have used lower velocities, say 500 to 700 fps, with relatively large reactant flows and found the flame to burn rapidly and to be quite homogeneous. It resembled something similar to a sharp gas flame. But our objective is not to burn oil like a gas. On the contrary, we aim to burn oil rapidly in large quantities with a minimum of atomizing diluents to form a sharp and clearly defined flame with high momentum. With this type of flame, the mechanical impact or striking force is sufficient to generate active currents and flow patterns in the slag and we hope, in the steel. We feel these currents should increase heat transfer to the bath and contribute to chemical uniformity.

Steam has unusual physical and mechanical properties. With steam you can achieve a very high velocity and atomization efficiency, but it suffers thermally. You just cannot get enough heat to start the fuel off to the fastest job of burning. That is also what takes place with air or coke-oven gas for atomization. If you could heat these gases under pressure to 1500 or 2000 F, you could prepare the oil ideally for burning not only mechanically but also thermally.

Our objective is to do three things, first, we want to finely atomize fuel oil mechanically, which can be done adequately with steam. That has been demonstrated. Second, we want to use an atomizing agent at the highest possible temperature with the least amount of agent required in order to minimize the heat carried away by the agent from the flame. Third, jet atomization provides

temperature heat sufficiently above 2000 F to actually crack or pyrolize the oil. This increases flame emissivity thus increasing radiation heat transfer.

In answer to one question, I should like to repeat that we want a high velocity to get high momentum because momentum is a function of mass and velocity. We want to keep mass, however, to a minimum for the reason shown in Figures 2, 3 and 4, where the quantity of atomizing agent was shown on the abscissa and its effect on the ordinate. Whether the effect was the temperature of the oil prior to burning, the amount of high temperature heat available or the theoretical flame temperature, we want to keep the amount of required atomizing agent at a minimum.

I think I have answered Mr. Davies' question, "When do we use air or steam?" Compressed air for atomization, I am sure all of you well realize, has been used at various plants for a long time. The results are fairly well known and have been reported in the literature. The recent work at Ijmuiden, Holland, for example, has also borne out the good properties of air. Steam also has unique properties, but what we are looking for is something with superior properties to both steam and air and also compressed natural gas.

In regard to the question on roof life and the maximum root temperature, this has been of deep concern to all plants for many years. As to how high and where should the maximum temperature be, I was reading a statement the other day that seems to be an excellent criterion for controlling this temperature. It should be as high as possible with a maximum amount of fuel fired consistent with good refractory practice. There was a statement in a recent report from Ijmuiden which, in effect, said, "Fire a maximum amount of fuel to get the radiation as high as possible at the incoming end and provide a constant roof temperature from one end of the furnace to the other." Now, the large mass of combustion air coming through the uptakes, which may amount to as much as 50 to 75 tons per hr, serves somewhat as a temperature control on the roof where the flame temperature may be the highest. Although the preheated air temperature may be 2000 F or higher, its temperature is still considerably lower than the roof temperature at the point of burning. As long as we have this large air mass protecting the incoming end, I suppose the ideal flame would be characterized by maximum radiation at No. 1 door, providing the flame does not hit the roof, by minimum radiation at the outgoing end, and by a fairly constant roof temperature throughout. ▲

Available Translations

As a service to readers of the *Iron and Steel Engineer* a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those thought to be of primary interest to the American steel plant operator. These papers may be obtained from the Cooperative Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W. 1, England. All correspondence concerning price, ordering, and so forth should be directed to the preceding source.

830 Lipovetskii, A., et al.: "Experience in the Adoption of Mechanized Coolers in Section Rolling Mills," *Stal*, 1956, No. 9, pp. 798–802. (Abstracted in J.I.S.I., 1957, Dec., p. 362.)

963 Suchkov, I. A., and V. V. Burtsev: "Automatic Control of Gas Distribution in the Blast Furnace Shaft," *Stal*, 1958, Feb., pp. 110–113.

993 Bogdandy, L., and H. D. Pantke: "Use of the Dust Produced during a Converter Blow as an Indicator of the Refining Process when blowing with Oxygen-enriched Blast," *Stahl u. Eisen*, 1958, June 12, pp. 792–798.

994 Holler, P., and H. Smit: "Optical Method of Determining Temperature Behaviour during Refining in a Converter," *Stahl u. Eisen*, 1958, June 12, pp. 799–804.

992 Stenger, W., and O. Dahlke: "The New Hot Strip Mill of Borsig A.G." *Stahl u. Eisen*, 1958, Vol. 78, June 12, pp. 812–820.

1016 Speith, G., and K. Bungeroth: "Experience with the Continuous Casting of Steel in Western Germany." Paper presented to the Joint Technical Meeting of The Iron and Steel Institute and the Journées Internationales de Sidérurgie, at Charleroi, June, 1958.

1049 Lueg, W., and P. Funke, Jr.: "The Calculation of the Effect of the Rolling Speed on the Rolling Effort and the Strip Thickness in Cold Rolling," *Stahl u. Eisen*, 1957, Vol. 77, Oct. 3, pp. 1356–1362.

999 Orlov, S. I.: "Reducing the Size of the Crop Ends of Tubes when Rolling on Continuous Mills," *Stal*, 1958, Apr., pp. 335–339.

1044 Borodin, V. P., et al.: "Four-phase Scheme of Integrated Automatic Control of Open Hearth Furnaces," *Stal*, 1958, Feb., pp. 114–120.

1069 Schleicher, W., and K. Boleg: "A New Oil Firing System for Open-hearth Furnaces," *Stahl u. Eisen*, 1958, Aug. 7, pp. 1108–1109.

1075 Nagami, K., et al.. "On the Distribution of Oxygen in Molten Steel during Refining," *Sumi. Met.*, 1958, Jan., pp. 1–4.

876 Speith, K. G., et al.: "Desulphurisation in the Basic Converter," *Stahl u. Eisen*, 1958, Feb. 6, pp. 152–156.

903 Pottgiesser, H.: "Decarburising Reaction in the Basic Bessemer Process during Dephosphorisation," *Stahl u. Eisen*, 1958, March 6, pp. 291–298.

928 Shuralev, M. V., and S. G. Nekrasov: "Calculation of Rolling Spread," *Stal*, 1958, Jan., pp. 57–60.

964 Mankher, L.: "Defects in Steel Wire," *Kohaszati Lapok*, 1953, Nov., pp. 225–239.

1041 Chekmarev, A. P., and G. I. Gylyaev: "Roll Design for Reducing and Sizing Mills," *Stal*, Rolling and Tube Manufacture Supplement, 1958, pp. 276–294.

1061 Andreev, V. F.: "On the Efficiency of Using Oxygen in the Iron and Steel Industry," *Stal*, 1958, June, pp. 561–568.

Hydraulic Jet Descaling—
a new method to remove scale from hot steel

by Benj. G. Harmon, Senior Partner, Harmon and Co., Chicago, Ill.
and Robert V. Proctor, Vice President & Chief Engineer, Commercial Shear & Stamping Co., Youngstown, Ohio

. . . . hydraulic-jet descaling improves product quality, reduces water requirements for descaling, and practically eliminates the undesirable cooling of the workpiece during the descaling operation . . . . the physical phenomenon on which it depends is the loosening of brittle scale by differential cooling . . . . the resultant shrinkage of the scale mechanically separates it from its parent metal . . . .

THE development of hydraulic jet descaling is the result of a demand for forgings free from embedded scale and scale pits. However, we could not find any manufacturer of a package unit for removing scale 100 per cent. Pumps and accumulators were available as were spray nozzles, but there was no combination of pumps, accumulators, spray nozzles and mechanism to do descaling.

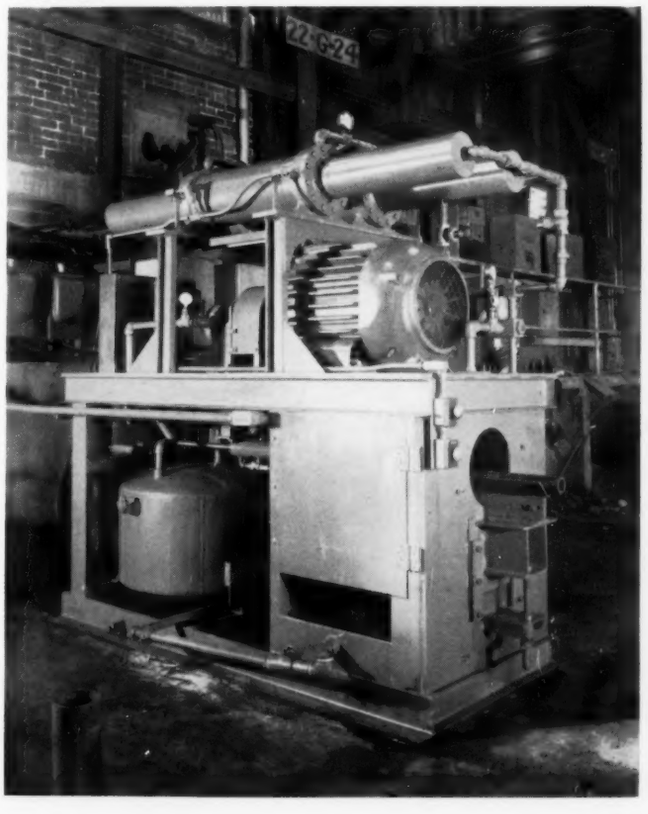
We were faced with a difficult design problem. A centralized system involved a lot of brain work and expense.

However, a packaged descaler for serving one upsetter was developed. A new principle for developing high pressure water for descaling was conceived. An inexpensive gear pump, submerged in oil, was used to produce a high oil pressure (up to 2500 psi). High oil pressure was converted into high water pressure in a cylinder. The oil, entering the cylinder behind a piston, drove the piston forward to expel water ahead of the piston.

In preparing round bars for forging, a ring of spray nozzles was used first. At the time the only water information available called for four to six gal per descaling cycle. The unit shown in Figure 1, was built to provide eight gal of water at pressures up to 2000 psi. Nevertheless, this unit using spray nozzles, only removed 60 to 80 per cent of the scale. This brought up the question, what actually *does* the descaling?

By analysis it was concluded that the sudden chilling of the crust of scale caused it to shrink and separate itself from the hot parent metal beneath. The scale was flushed away by the surplus water. The scale was not loosened by the mechanical force of the water but by the shrinkage of the scale without a corresponding

Figure 1 — The first experimental hydraulic jet descaler built before the physical phenomenon of hydraulic-jet descaling was known, was only 60 to 80 per cent effective in descaling even though it delivered eight gal of water per descaling cycle (much more than the optimum delivery rate later established) at 2500 psi for descaling round bar forgings.



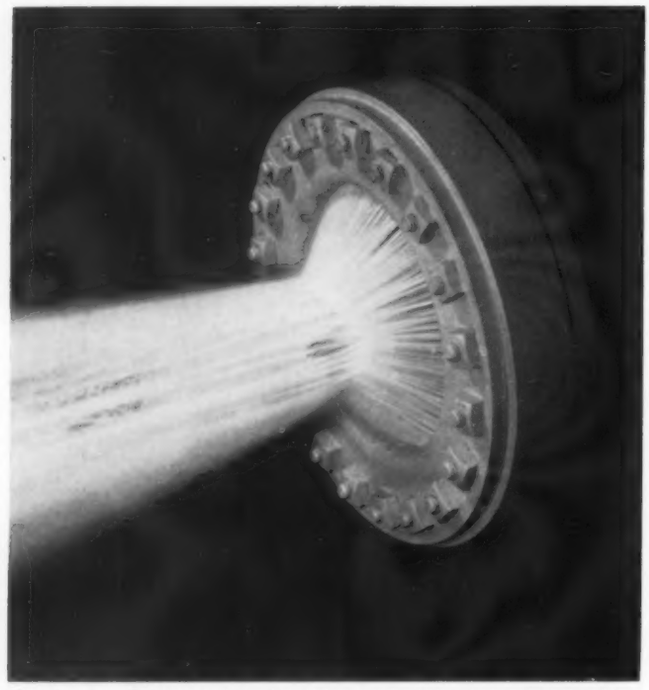


Figure 2 — This hydraulic-jet ring produces a converging, conical jet of water and is aimed at the axis of the work piece. The work piece is advanced along the axis of the water cone and through the center of the ring quickly enough to effect a differential shrinkage, between the scale and the parent metal, that will result in descaling.

contraction of the parent metal. Therefore, it was found advisable to hit the crust of scale with just enough water to chill it but not enough to materially cool the parent metal. This caused the scale to "pop off."

Further analysis showed that, to use shrinkage to best advantage, it was necessary, for sudden chilling, to hit the scale in a narrow band. A time element was involved. When the workpiece was fed through a wide nozzle spray zone, the scale was cooled gradually, not suddenly. There was time for the cooling effect of the water to penetrate the scale to the parent metal beneath. Thus the full shrinkage effect was not utilized. As a result, some of the scale was not loosened.

A different means of applying the water was needed. Because nozzles are divergent, they must be spaced apart. The wider they are spaced the further they are from the hot steel. For complete coverage the spray nozzles are angled for lap. When the pattern of impingement is large, the chilling of the scale is more gradual; and the temperature difference between the scale and the parent metal beneath is reduced.

To properly apply the water to round and square work the jet ring was invented. Figure 2 shows the jet ring. This produced a convergent cone of water aimed at the axis of the workpiece. The jet ring was designed for an extremely narrow impingement band. With the workpiece progressing through the conical jet, there was no time for the chill to penetrate the scale to the parent metal beneath. Thus, full use of the scale shrinkage was realized.

When the jet ring was substituted for the nozzle ring in the unit shown in Figure 1, much better results were obtained. Instead of requiring four to six gal of water per cycle, a 3-in. bar 18 in. long was perfectly descaled with less than one qt of water. This enabled us to bring out our first hydraulic-jet descaler for the forging industry. Figures 3 and 4 show such a bar before and after descaling a length of 18 in.

The next step was to find the fundamental cause of chilling. Obviously, only the water droplets that hit the hot scaly surface could chill the scale. As might be expected, the first droplet from the jet exploded into steam when it contacted the hot surface. This violent explosion blew succeeding droplets away. In order to have a chilling effect, the following droplet had to have sufficient mass and velocity, or simply sufficient kinetic energy, to penetrate this exploding steam and actually hit the scaly surface. Droplets, without sufficient kinetic energy, recondensed the steam and thus lost energy.

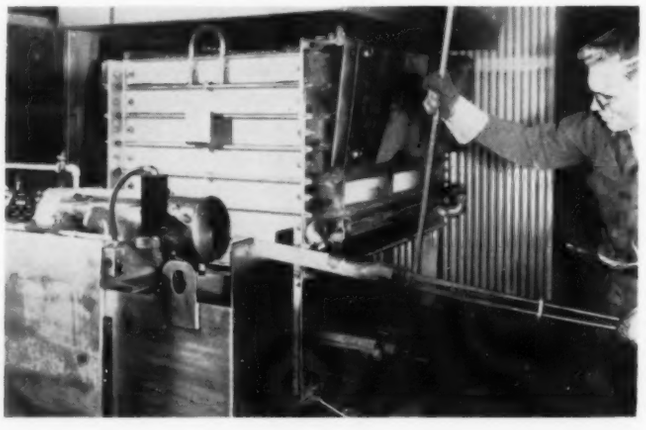
Trials indicated that, for carbon steel, a jet pressure of 1200 to 2000 psi was required for driving the droplets through the steam blanket. Experiments were conducted up to 2900 psi and down to 1000 psi. Above 2000 psi the droplets were too small to penetrate the steam blanket. At 1000 psi the droplets were large enough but did not have enough velocity to drive through and impinge on the scale.

Actually, in a jet, more water was discharged than necessary for chilling the scale. This function required but a fraction of the water discharged. A portion recondensed the steam, and the other portion, plus the recondensed steam flushed away the loosened scale.

The first units supplied the knowledge that helped bring out practical forge shop descalers.

Figure 3 — A heater is shown here inserting a hot 3-in. round in a hydraulic-jet descaler.

Figure 4 — The same bar, shown in Figure 3 before descaling, is being removed from the descaler. One hundred per cent of the scale was removed in 0.6 sec in the descaler.



In Figure 4 it will be noted that this descaler is but a fraction of the size of that shown in Figure 1. The hot bar can be loaded into a hopper by a conveyor, provided its length is not shorter than 1.5 times its diameter or thickness, and automatically discharged after descaling to another conveyor or chute for delivery to the press.

Figure 5 shows how the poke-in or slug-drop-in model descaler can be moved from one forging machine to another by a fork truck. Hooks are also provided for moving by overhead crane.

Figure 6 shows the "poke-in" type descaler for descaling only the ends of bars.

Figure 7 shows the "slug-drop-in" type descaler that descales slugs or the ends of bars.

The roller conveyor or "pass-through" type descaler is comprised of two parts: the descaling cabinet in which the actual descaling work is performed, and the power pack which furnishes the required high pressure water (2000 psi maximum) that is piped to the descaling cabinet.

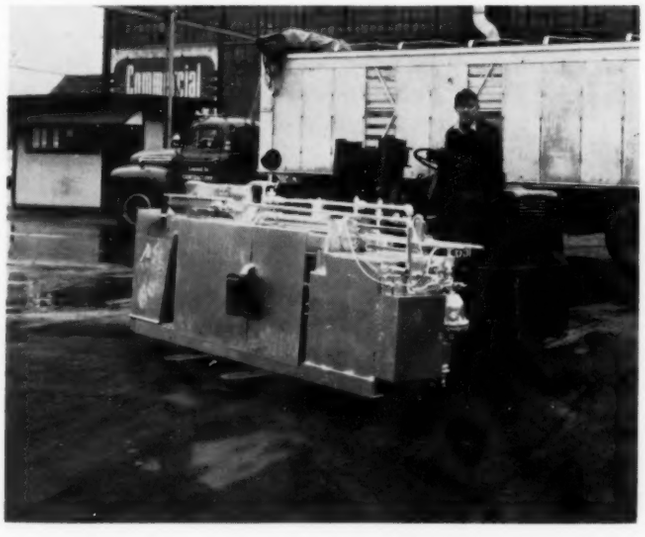
Figure 8 shows the descaling cabinet and a cold 6 in. billet that has just passed through it.

Figure 9 shows the power pack which automatically furnishes high pressure water as the billet passes through the descaling cabinet. This water is delivered by a high pressure pipeline to the jet ring or the jet bars in the descaling cabinet. The motor, shown in the power pack, drives a submerged gear pump through the wall of the oil reservoir. The oil-water pressure converter cylinder is shown above. Oil is pumped into one end against the piston which drives high pressure water out of the opposite end.

The jet bar, shown in Figure 10, was invented for descaling flat products. The paths of the droplets are not convergent like they are in the jet ring—they are parallel. When the water emerges from the jet bar, it is in the form of a sheet. At a short distance from the jet bar, surface tension forms very closely spaced streams of larger droplets giving practically a solid sheet of high pressure water.

Figure 11 shows a cross section of a jet ring. The knife edge is held on its seat by pressure screws. These screws are pulled uniformally tight with a torque wrench to give the pressure desired, up to 2000 psi.

Figure 5 — A poke-in model descaler can be moved from one forging machine to another by a fork truck.



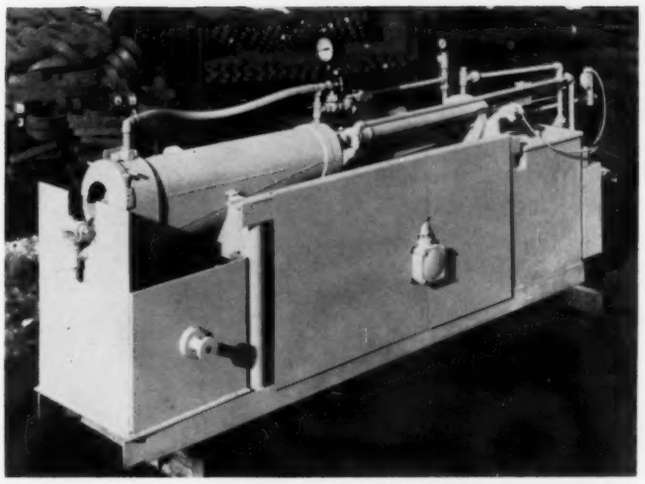


Figure 6 — This is a closeup of the "poke-in" type descaler for descaling only the ends of the bars.

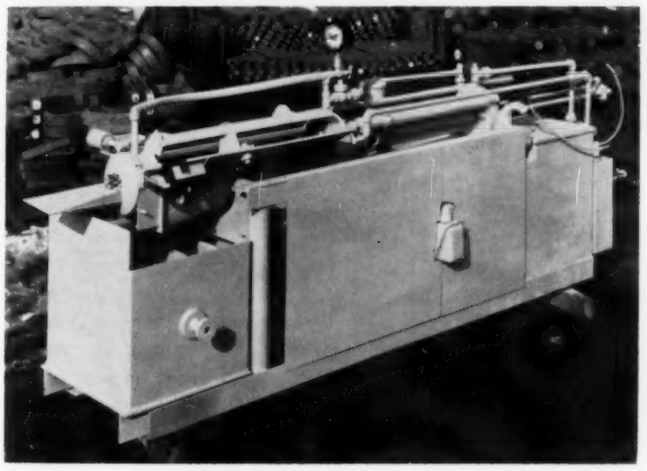
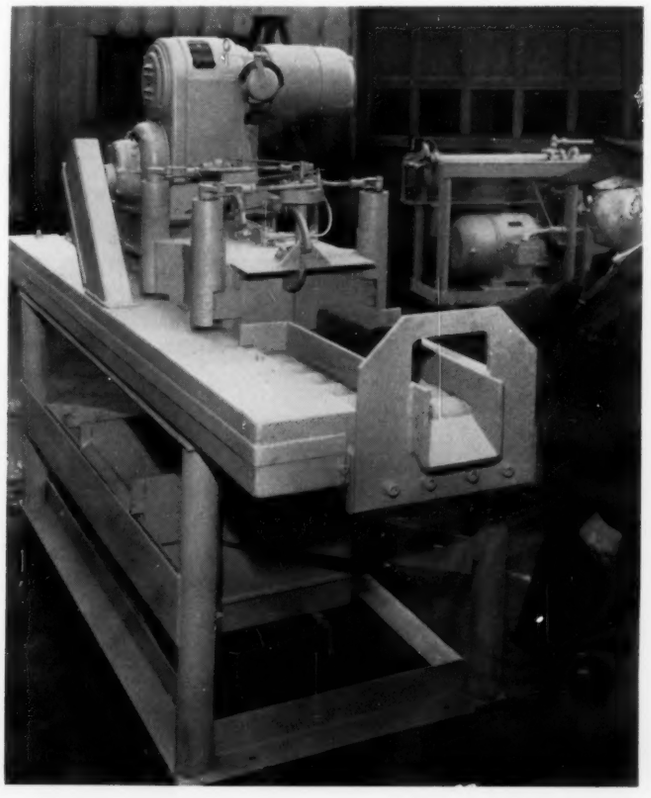


Figure 7 — Shown here is the "slug-drop-in" type descaler which descales slugs or ends of bars.

Figure 8 — A 6-in. billet is shown after having just passed through a descaler cabinet.



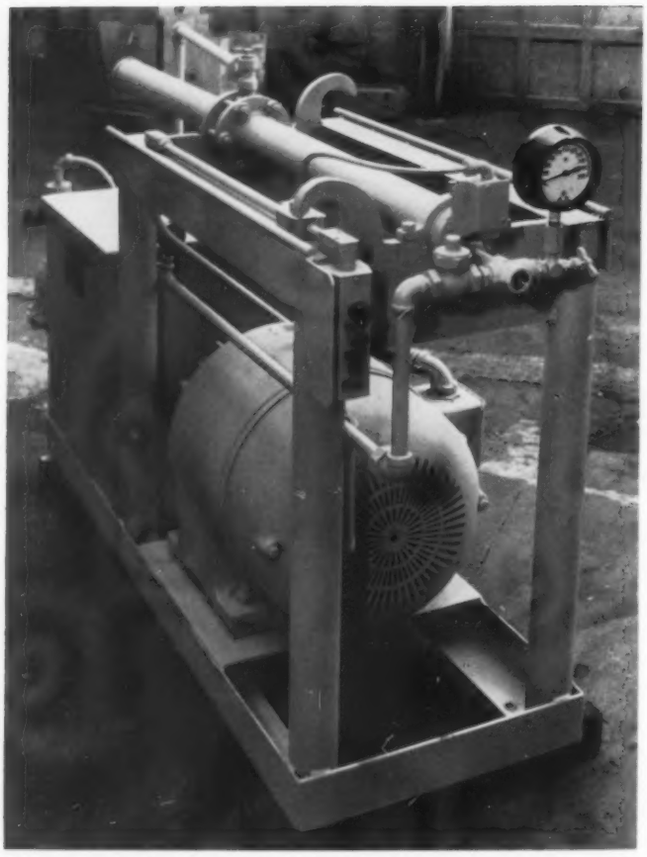


Figure 9 — Pictured here is the descaler's power pack which supplies the high pressure water to the jet rings or bars in the descaling cabinet. Its motor drives a gear pump which is submerged in the oil reservoir.

The knife edge of the jet bar is likewise held on its seat by the same pressure screws, and also is set by a torque wrench. Figure 12 shows a cross-sectional view of the jet bar.

Between working strokes, the water pressure in the chamber is only line pressure, and no water passes. The pump is idly circulating oil in the reservoir. When the workpiece approaches the jet, it triggers a valve which shuts off the oil circulation. The oil must now go to the cylinder. It drives the piston forward and expels water against all resistance. The resistance is the tightness of the pressure screws. Pressure builds up high enough to elongate these screws. The slit opens slightly, and water

Figure 10 — Shown here is a jet-bar type descaler for descaling flat products. The surface tension of the water forms very closely spaced, parallel streams of large droplets.

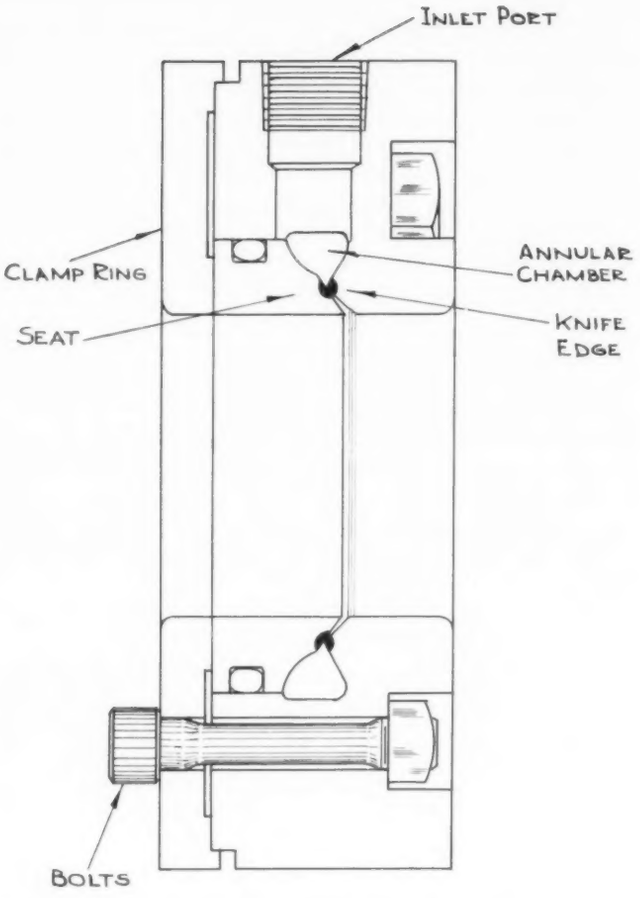


Figure 11 — This cross-sectional view of a jet ring shows how tightening its pressure screws varies the water pressure by changing the seating force on the knife edge.

emerges in a thin sheet. The pressure is determined by the torque wrench setting. At the end of the work cycle, the pump is unloaded to prevent any possibility of water hammer. The tension screws contract to close the slit, and the piston retracts to refill the cylinder with water and discharge the oil back into the reservoir.

To get started in the steel industry without interfering with the production of a large and expensive hot strip mill, it was suggested that an application at the United States Steel Corp. Research Center at Monroeville, Pa., be found. Shortly thereafter, U. S. Steel engineers found scale was giving them erratic results in one of their rolling research projects. At their request, we supplied a descaler for their temporary use. This descaler took off the scale, and the research project was successfully completed. The research laboratory used it for 15 mo. It furnished our engineers the additional information needed to tailor our descaling facilities to steel mills.

The past year or so has been spent visiting and studying hot strip, plate, bar, tube, and extrusion mills.

As a result of our first visits to hot strip and plate mills, it was felt that using a hydraulic-jet descaler at only one location would suffice. This was ahead of the No. 1 scale breaker for removing from the slabs, the hard furnace scale and any spalled pieces of refractories, which fell from the furnace roofs onto the slabs before their entry into this roll stand.

However, because the very small quantity of water required (only one quart to three pints per sq ft for

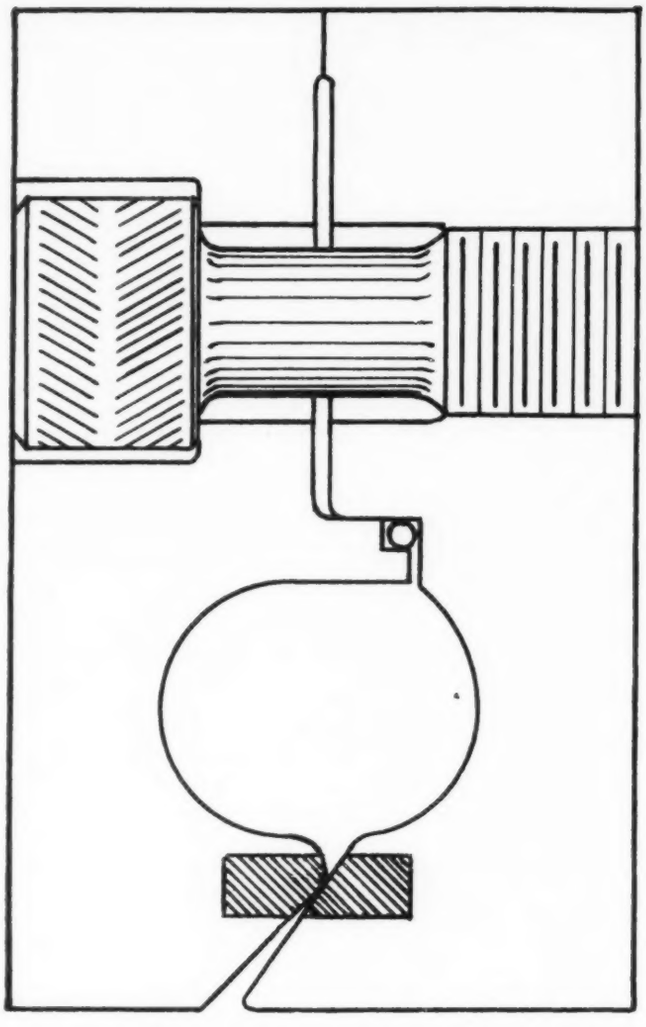


Figure 12 — The water pressure of a jet bar is adjusted by means of pressure screws, the same as the jet rings, as shown by this cross section of the jet bar.

removing furnace scale) appealed to several steel mill people, it was decided that hydraulic jet descaling would also be especially beneficial ahead of No. 1 finishing stand. The steel mill people thought that the reduced cooling of hydraulic jet descaling would be especially beneficial to the life of the rolls and would permit rolling of thinner gauges.

As a result, hydraulic-jet descalers are offered in two separate packaged units, namely, the No. 1 descaler and the No. 2 descaler for installation on continuous hot strip and plate mills as follows. The No. 1 descaler is for location ahead of No. 1 scale breaker or behind the vertical edger if the mill is so equipped. This descaler is for removing the hard furnace scale from the top and bottom surfaces before the slabs enter No. 1 scale-breaker or No. 1 roll stand as the case may be. It also takes off any spalled pieces of refractory brick that ride on the slabs thus preventing their being rolled into the soft steel.

Figure 13 shows a longitudinal section and half plan view of a No. 1 descaler recently proposed for installation ahead of the No. 1 scale breaker on a 56 in. hot strip mill. The slab is shown entering the mill, located to the left, immediately after descaling. To take care of "turn-ups" and slabs of different thicknesses, the upper jet bar holder is mounted on a swinging scoop. This scoop picks up the ricochet water and the scale and passes it back and to one side of the approach table for delivery to the scale pit beneath. Picking this water up, in this way, prevents it from prematurely chilling the crust of scale before the upper jets strike it. This gives the sudden chilling needed to cause the scale to instantly shrink and "pop-itself-off." The small quantities of water that jet bars employ cool the slabs but very little. As a result the draft on the No. 1 scalebreaker can be greatly increased. This, in effect, changes it to a rougher and as a consequence, increases rolling capacity.

The No. 2 descaler, for location ahead of the No. 1 finishing stand, is for removing, from the top and bottom surfaces of the semi-rolled strip, the "air scale" or secondary scale formed during roughing. Figure 14 shows a longitudinal section and a half plan view of a No. 2 descaler recently proposed for installation after the No. 2 scalebreaker shown on the left and ahead of the No. 1 finishing stand shown on the right. The space available for this installation is so limited that a return type of swinging scoop with curved vanes is required to pick up the ricochet water and scale and to divert it sideways to vertical chutes for delivery to a scale pit beneath. It will be noted that the upper jet bar holders are also attached to a swinging scoop to take care of turn ups and different thicknesses of the semi-rolled strip.

Figure 15 shows a plan view of a No. 1 descaler proposed for a 98 in. hot strip mill. The jet bars on the left are the upper ones. Three 13½-in. long jet bars lie in one slot, and two 13½-in. and two 6-in. jet bars lie in an adjoining second slot.

The jet bars on the right are the lower jet bars. Starting from the right, there are four slots for these lower jet bars with one 6-in. jet bar in the first slot, one 13½-in. and one 6-in. jet bar in the second slot, two 13½-in. jet bars in the third slot and two 13½-in. jet bars in the fourth slot.

The jet bars on the left are the upper jet bars, contained in two slots. Starting at the right there are two 6-in. jet bars and two 13½-in. jet bars in the first slot and three 13½-in. jet bars in the second slot.

All jet bars are to be used when the widest slabs are rolled. The appropriate wing bars are to be shut off and their mating power packs cut out when narrow slabs are rolled.

A second reason for multiple jet bars located in parallel slots is to keep them light enough for manhandling so that they can be changed quickly. The feed hose can be quickly unsnapped from the header and used to jerk the jet bar up out of its slot.

Jet bars will not need to be changed as often as spray nozzles. Also, instead of throwing them away—as spray nozzles are they can be taken apart, cleaned, relapped, reassembled and retorqued for use when needed. Jet bars can be used many times and will last for years. To insure continuity of operation a complete spare set of jet bars is included with each descaler.

Figure 16 shows a longitudinal section of the hydraulic jet application proposed for this same 98-in. hot strip mill. The catwalk provides easy access to the jet bars, both top and bottom.

The swinging scoop picks up the ricochet water and scale from the top surface of the slab. It either sends it

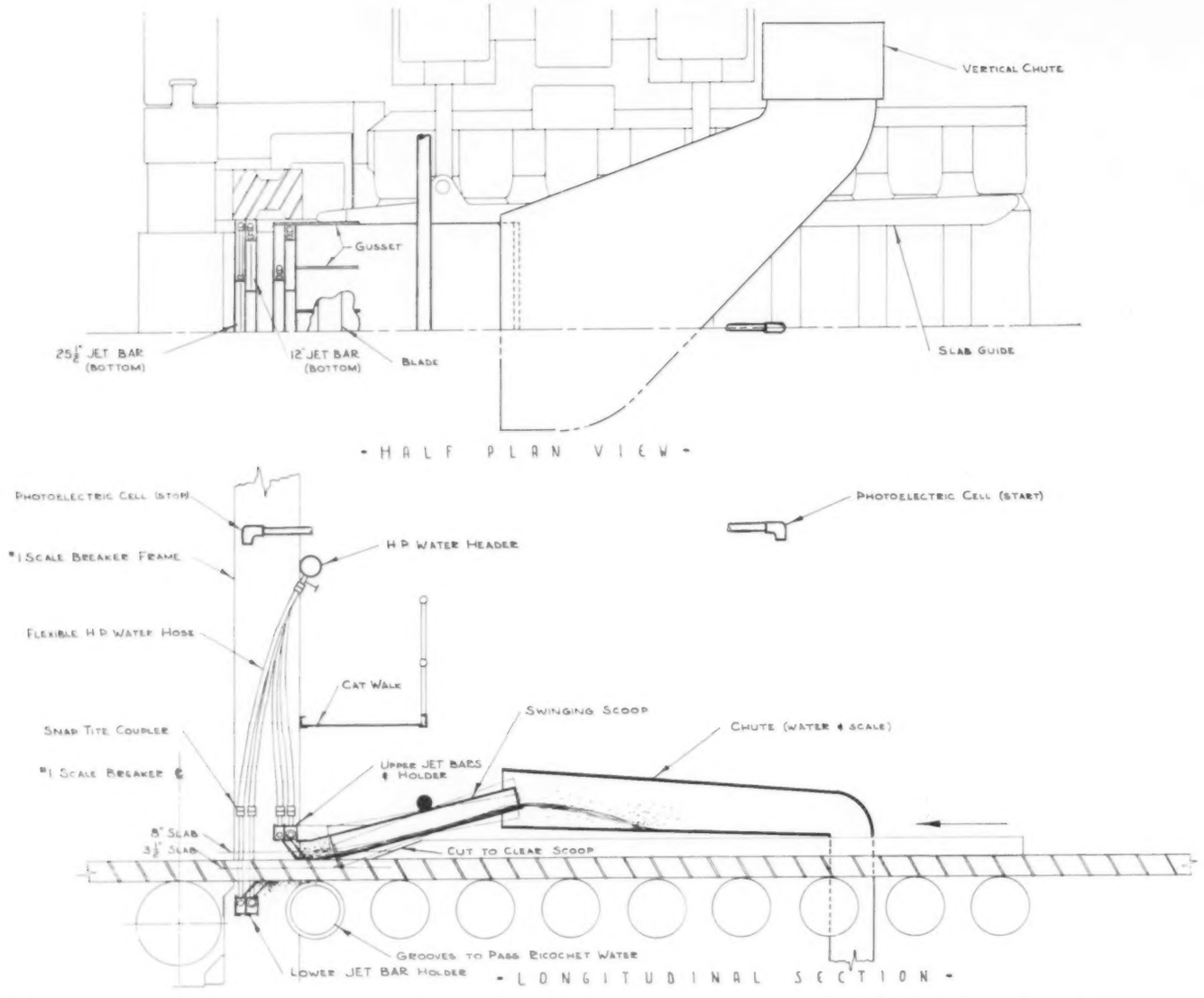


Figure 13 — This No. 1 descaler is located ahead of the No. 1 scalebreaker of a 56-in. hot strip mill. Note the swinging scoop and chute for removing ricochet water from the top of the slab. This permits continuation of the sudden chilling of scale crust by preventing premature cooling of that scale adhering to that portion of the slab which has yet to advance through the jet.

back to the end of the slab, or carries it sideways to chutes which carry it down past the guides to the scale pits. As previously explained, the picking up of this water prevents premature chilling of the scale before striking the narrow bands of high pressure water ejected by the jets.

The upper jet bar holders are also attached to the swinging scoop, the same as shown in Figures 13 and 14. This takes care of turn-ups. It also insures that the positions of the upper jet bars are maintained at a constant height above the top surfaces of the slabs.

Because jet bars use so much less water to remove scale than do spray nozzles, the semi-rolled strip is much hotter entering the finishing train.

Steel can be rolled thinner and with better shape because of the increased temperature at the five finishing stands. Descalers are offered in three packaged units for semi-continuous hot strip and plate mills.

The No. 1 descaler is to be located ahead of No. 1 scalebreaker or after the edger, if there is an edger ahead of the No. 1 scalebreaker. This descaler is for removing the hard furnace scale from the top and bottom surfaces of the slabs before entering the first horizontal rolls.

The No. 2 descaler is for installation ahead of pass No. 1 on the reversing rougher or three-high rougher. This descaler will be automatically elevated after the trailing end of slab passes so that it will be out of the way of pass No. 2. This descaler will remain in its elevated position until brought down by the operators pushing a button in the pulpit to redescale all odd-numbered, subsequent passes.

The No. 3 descaler is for installation just ahead of the first finishing stand for removing "air scale."

We are also offering our descalers for billet and bar mills. From our observations, very few of these mills do any descaling. As a consequence, some of the hard furnace scale is rolled into the soft steel presenting difficulties to purchasers of steel for forging or machining.

It had been suggested that descaling in steel mills should really start on the hot ingots. Our hydraulic jet descaling laboratory conducted descaling research on thick scales such as those experienced in heating ingots

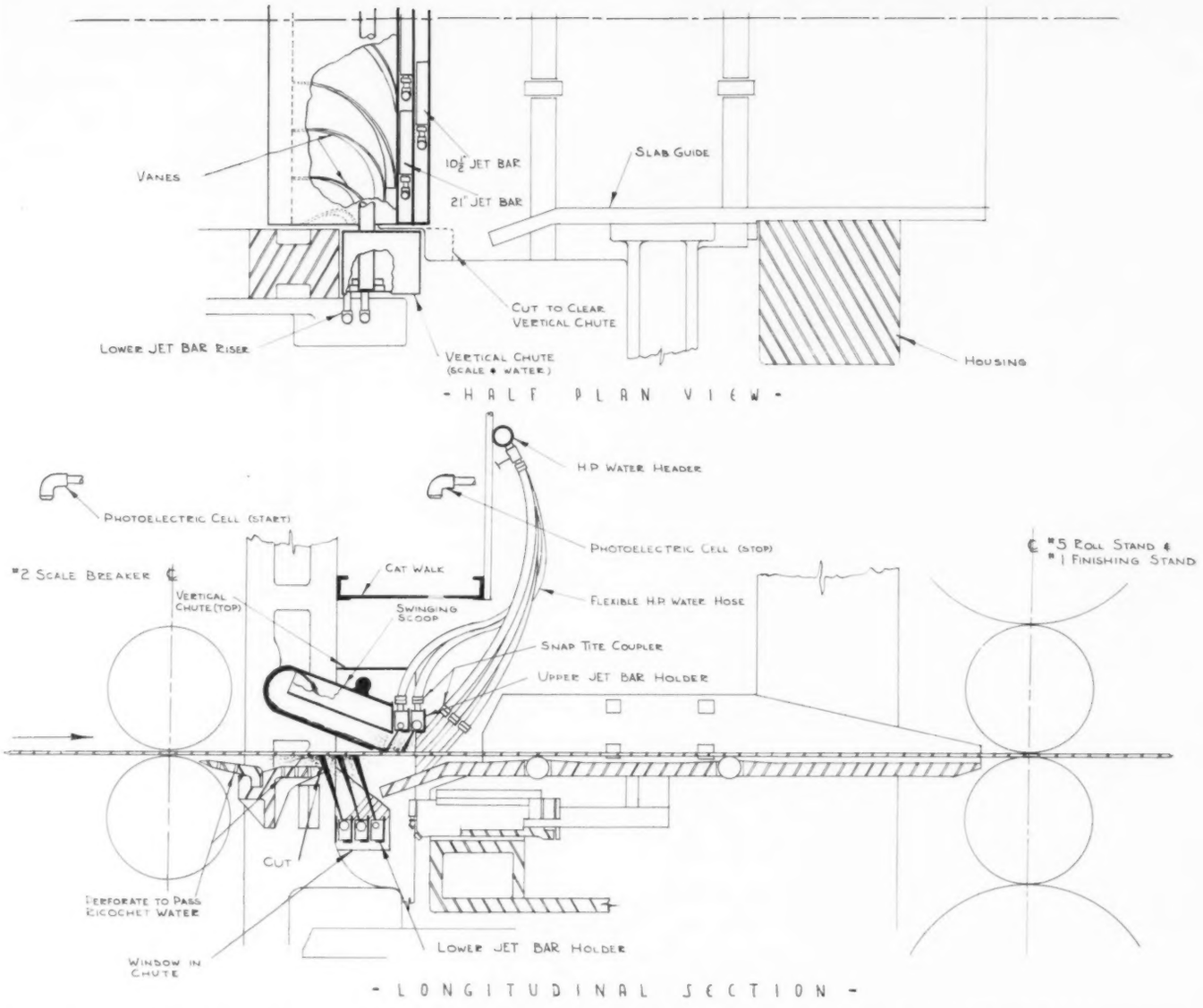


Figure 14 — The No. 2 descaler shown here is proposed for installation between No. 2 scalebreaker and No. 1 finishing stand. Because of space limitations a return type of swinging scoop with a vertical chute is to be used.

in soaking pits. To simulate soaking pit heating conditions, 5½-in. carbon steel slabs were heated for 35 hr at 2250 F in a slightly oxidizing atmosphere. The 7/16-in. thick crust of hard scale, which resulted from this prolonged heating, was broken up and completely removed by a jet bar with a total discharge of only three pints of high pressure water (1800 psi) per sq ft.

Descaling the ingot will certainly reduce the cost of manual cold scarfing slabs and blooms. It will also economize continuous hot scarfing. The per cent of steel lost in scarfing will be held to a minimum.

Hydraulic-jet descaling also has an application in the heat-treatment of certain steel products.

The quickest quenching induces the highest physicals, but scale is an insulator. It mitigates against speedy temperature drop through the critical zones, which is so desirable for attaining the best physical properties.

Where the physical shape of the rolled product is suitable for hydraulic jet descaling, as are plate, oil well casing, drill pipe, track shoes, etc.; scale can be removed ahead of the quench with an extremely small amount of water. The scale will be chilled without cooling the steel. This causes the scale to instantly "pop-itself-off," but the temperature of the steel will remain above its upper critical range. Steel, entirely free from scale, enters the quench and allows faster as well as more uniform quenching. This is because scale, like aluminum foil, is an insulator, and its presence retards the speed of cooling. Higher physicals can thus be obtained, or smaller quantities of chromium, molybdenum, and other strength producing ingredients can be used. Speedier quenching permits quenching of greater tonnages thus raising the quenching capacity more nearly to the heating capacity.

In all mill applications, the hydraulic jet descaling facilities must be most carefully engineered to meet all the variable conditions encountered.

Currently nozzle spray descaling practice varies according to the location and number of spray stations. Generally, however, the slab is sprayed after the No. 1 edger, if any, and either ahead of or behind the No. 1 scalebreaker.

Additional sprays in the roughing passes try to remove the rolled-in scale. This is exceedingly difficult to do because the shrinkage condition is different.

Then, as the semi-rolled piece emerges from the rough-

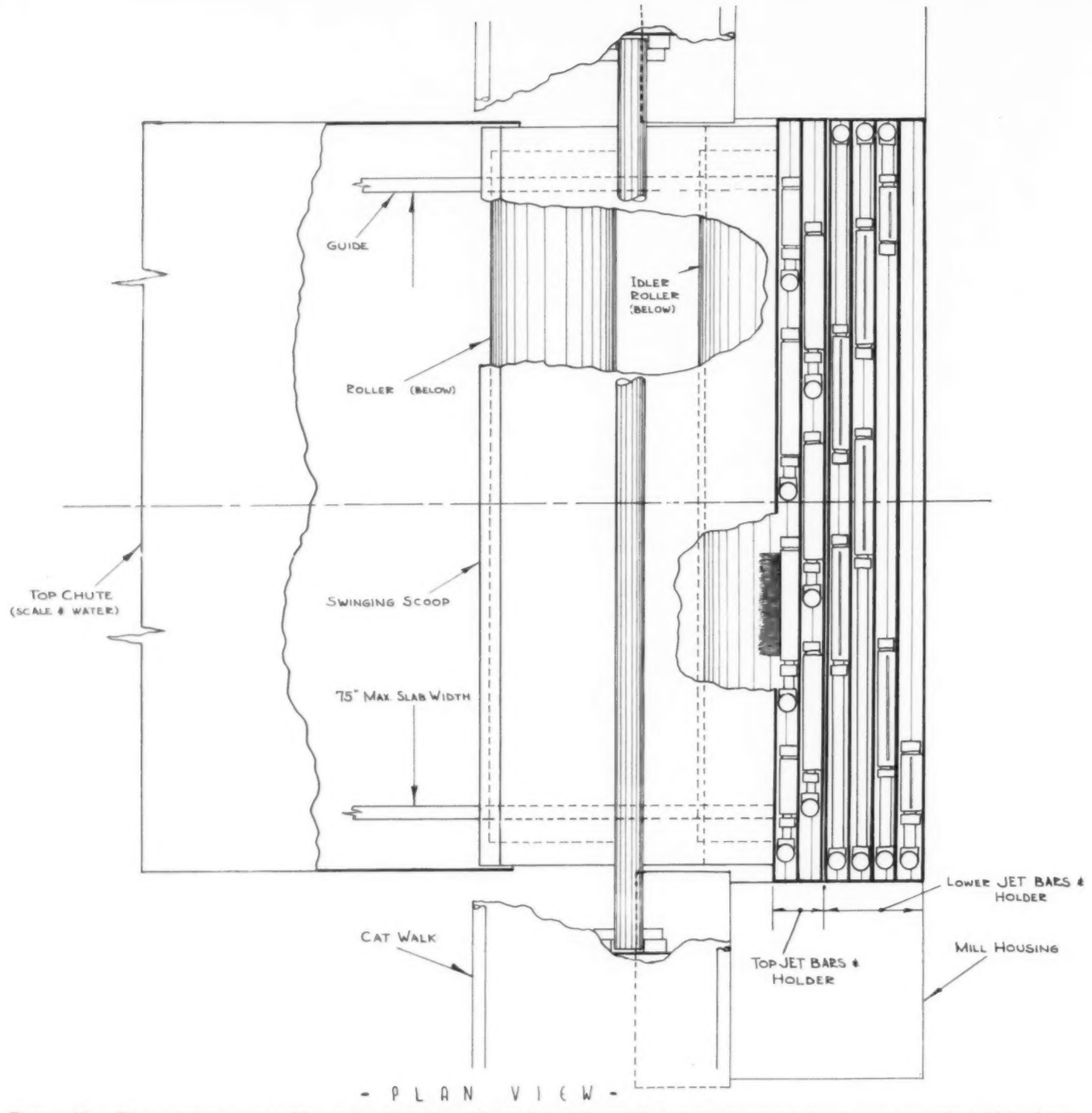


Figure 15 — This plan view of a No. 1 descaler for a 98-in. hot strip mill shows the arrangement and number of jet bars. All of the jet bars are used for wide slabs while only the center ones are used for narrower slabs.

ing train, it is sprayed one, two, or three times more in an endeavor to remove the last vestiges of rolled-in scale before it enters the No. 1 finishing mill. The overall effectiveness varies. Spraying so many times with such vast quantities of water undesirably cools the steel.

If this descaling were 100 per cent effective, there would be no place in the picture for hydraulic-jet descaling. With hydraulic-jet descaling the temperature of the furnace can be kept within limits that will eliminate much of the furnace damage now experienced in many applications and still deliver steel through the roughing trains without loss of temperature.

The underlying principle of hydraulic-jet descaling is to hit each square inch of scaly surface with the proper volume of water, at the proper pressure, and applied in the proper manner, to effectively remove the scale. A corollary to this is that steel must be heated to the proper temperature in a proper atmosphere to form a scale that can be removed hydraulically.

There are numerous variables encountered. An important one is scale thickness. Carbon steel and low alloys generally form the thickest crusts. It varies with time in the furnace, but it is not a direct variation. It also varies with temperature. Carbon scale requires the maximum amount of water and pressure for removal.

In contrast, stainless 302 forms a very thin scale. Hitting it with carbon water and pressure would remove no scale at all. The thin scale passes the cooling effect to the parent metal beneath so there is practically

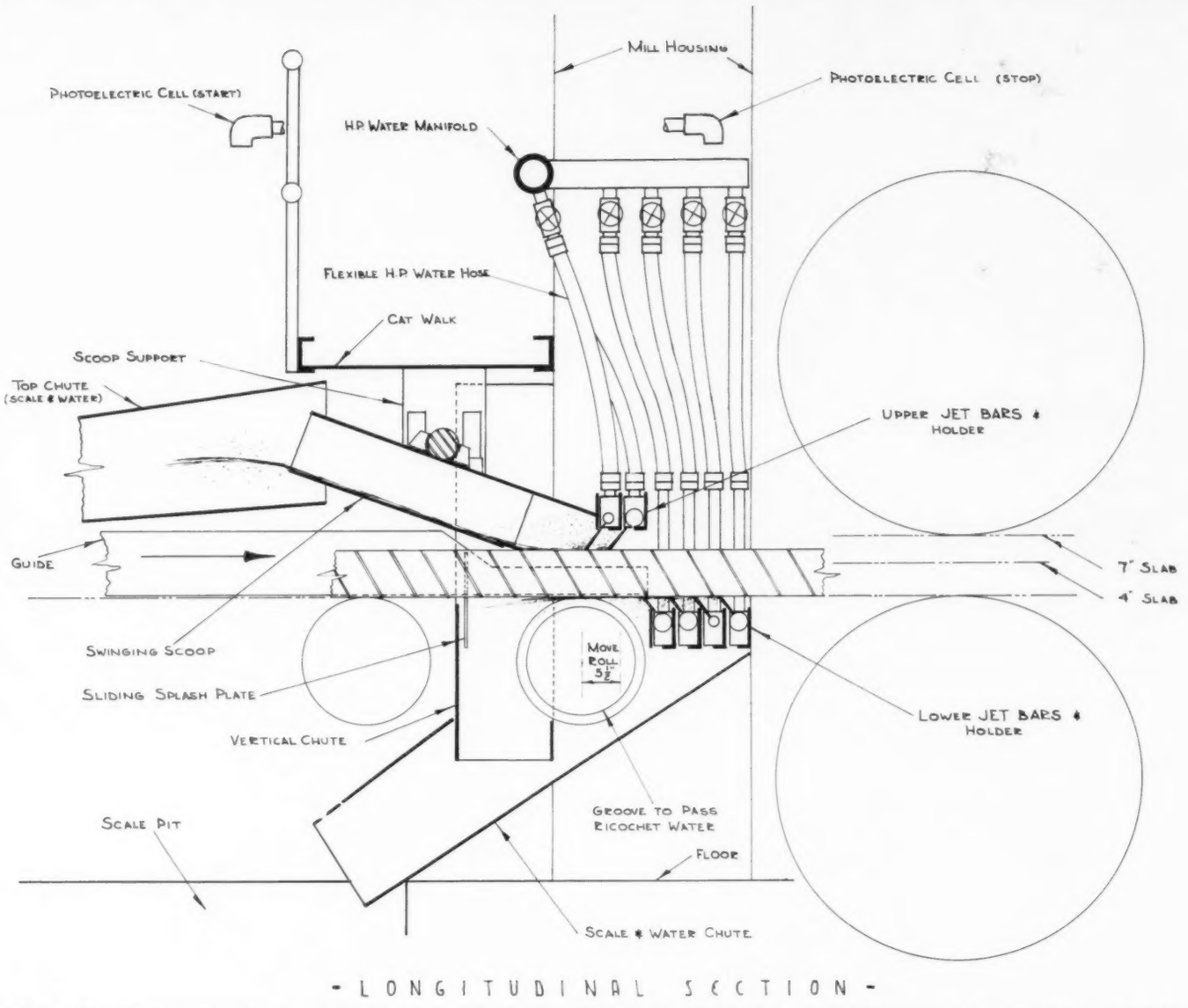


Figure 16 — This longitudinal section of a hydraulic-jet application on a 98-in. hot strip mill shows the catwalk from which jet bars are easily replaced.

no shrinkage differential. Water and pressure must be cut down.

Still other variables are with speed and frequency. All these variables, and more, must be reckoned with when proportioning hydraulic-jet descalers for any mill. To meet the variables, hydraulic-jet facilities are purposely made flexible.

The scale condition, width and speed variables all require water delivery with rate flexibility. Instead of one big unit, several power packs are used. A small one is shown in Figure 9. Power packs are mounted in one group on a good base. They are manifolded together in parallel so that they act as one big unit. A spare is always included to insure continuity of operation. A power pack is cut in or out by the flick of a switch. In this way the rate of water delivery is changed to meet certain variables. Power packs operate intermittently. Water is stored in the converter cylinders, which refill between working strokes. Cylinder capacities are large enough to maintain the maximum discharge rate longer than the longest working cycle.

However, in some locations the time interval between working cycles is too short for the cylinder to refill. This is particularly true just ahead of the No. 1 finisher. There are four options to satisfy this variable.

1. The power packs can be equipped with double cylinders, which automatically alternate, one set firing while the other set refills.

2. Reciprocating, high pressure pumps that operate continuously, can be used. The choice is usually made on a money basis. The pump group is comprised of several of the smaller vertical, triplex pumps, selected for the flexibility reasons mentioned above. A spare pump is incorporated into each group.

In cases where the interval between the working cycles is too short for refilling the cylinders of power packs, yet triggering the jets off and on is justified, unloaders are provided for the reciprocating pumps. This forestalls water hammer in the pipelines.

3. If a centrifugal pump of sufficient capacity and a pressure up to 1000 psi maximum is available, economy can be improved in the use of reciprocating pumps by having a centrifugal pump deliver water under pressure to the intake side of the reciprocating pumps thereby decreasing the horsepower requirements of their motors.

Figure 17 — At the top is a 5½ x 6- x 13-in. carbon steel slab, which had been heated three hours in a furnace to 2250 F, before descaling. The same slab is shown below shortly after having been descaled in a hydraulic-jet descaler.

4. If a centrifugal pump of sufficient capacity and a pressure rating of 1500 psi is available, it can furnish high pressure water direct to the jet bars of the No. 2 descaler of a continuous mill or the No. 3 descaler of a semi-continuous mill.

Figure 17 shows a minature carbon steel slab immediately before and after descaling by a hydraulic-jet descaler.

In designing hydraulic-jet descalers, utmost thought and care is given to maintaining continuity of operation. Spares are either built in or provided. All mechanisms are rugged and designed for minimum maintenance costs and especially for quick and easy servicing.

Discussion

PRESENTED BY

ROBERT V. PROCTOR,
Vice President & Chief Engineer,
Commercial Shearing & Stamping Co.,
Youngstown, Ohio

E. A. RANDICH, Mechanical Engineer,
Allegheny Ludlum Steel Corp.,
Brackenridge, Pa.

S. O. EVANS, Manager of Tubing Operations,
Tubular Products Div., Babcock & Wilcox Co.,
Beaver Falls, Pa.

R. C. SCHAEFER, Superintendent Hot Strip Mill,
Wheeling Steel Corp., Steubenville, Ohio

Member: I would like to ask what life expectancy the authors expect to get from this jet bar, how much maintenance have they experienced and where we would see one now in use?

Robert V. Proctor: We do not have an installation in any mill as such and therefore some of these things cannot be answered. The jet bars appear to have an indefinite life. They have to be cleaned occasionally. This is a function of how dirty the water is. Very dirty water will clog a jet bar and it will have to be disassembled, cleaned out, relapped, reassembled and retorqued before being put back into service again.

We do not have a life figure on the converter cylinders because none have worn out as yet. Several of them are in service at a couple of automotive forge shops. They are operating somewhere around 300 strokes an hour. We have never sold them any packing and do not have the slightest idea how long they will go before they have to be repacked. That is about all that will have to be done to them.

Tests have shown that our jet bars and jet rings open up 0.003 to 0.006 in.—0.003 in. is 75 microns. If the water contains no particles larger than 40 microns, it is a long time before the jet bars or rings clog.

So-called "city" water passes this requirement when it leaves the filtration plant. However, the distribution pipes become rusty and a certain amount of rust is carried to the descaler. The amount is very small. To meet this condition, descalers furnished for the forging trade have a cartridge type filter in their water line to filter out particles of rust. In our shop it has been a practice to change the cartridges about once every three months.

In a mill installation, where the water used for descaling is city water, the same type of filtration would be installed on the power packs. Of course they would be of considerably larger capacity due to the larger volumes.

However, in most installations that we have surveyed, the water available for descaling is not city water, nor is the water river, lake or spring water, treated for removal of solids down to 40 microns. In these cases the power packs are equipped with automatic cleaning filters, which remove solids down to 40 microns. These filters are continuously self-cleaning. When installed on power packs they are equipped with a valve and two timers. They are connected electrically so that the valve in the drain line at the bottom of the filter opens, and the sludge is flushed out for a predetermined number of seconds when the power pack motors are started. The other timer will function to open this valve again at a given interval, which is adjustable, while the motor is running. The setting on the two timers is a matter of trial and error.

In those cases where the raw water, treated by the mill, is apt to contain fibrous material as well as granular material, a self-cleaning and self-desludging strainer is put ahead of the filter.

Member: Do these jet bars have a tendency to pit from the extra high pressures put through them? Do they pit, and how often do you have to grind them to keep their surface smooth enough that the opening, from the stretching of their bolts, is proper?

Robert V. Proctor: That is a moot question that we need more information on. We do not, as yet have any installations in a mill, but the experience on jet rings, which are made in a similar manner, indicates that very seldom do you have to take them out for relapping or grinding. They usually run somewhere around three or four months in our shop. With jet rings you have a similar life to that of the jet bars. Again, it is a function of the cleanliness of the water and naturally one of the important factors in designing a mill installation is making sure the water is clean. We provide filters to

clean the water to such an extent we know it should function all right.

With regard to the subject of pitting, our experience to date has been largely with jet rings although we have had some experience on jet bars. The construction of the jet rings is as follows. The smaller inner ring, which constitutes the knife edge, is a tool steel which is ring-hardened, ground, and highly corrosion resistant. The body is soft steel into which a seat of tool steel is built by welding. This seat is ground. The tool steel is also highly corrosion resistant. We have had no trouble from pitting of the knife edge or seat from corrosion. Neither have we had any trouble from erosion of the seat or knife edge by the high speed water passing between them, sometimes called "wire drawing."

The construction of the jet bars is different from the jet rings due to the different shape. Both body members of the jet bar are made from 4120 steel. These are rough-machined to size, and a groove is machined in each member. An insert of an air-hardened steel is fitted into each groove. One forms the seat and the other the knife edge. These are then copper brazed in a furnace into the body members. After brazing the members are heat-treated to bring the hardness of the seat and the knife edge up to between 65 and 70 Rockwell. Then the bars are machined, ground, lapped and assembled. The tension screws are uniformly torqued, and the bar is tested for pattern. If necessary the bar is relapped, retorqued and retested. The steel used in the inserts is highly resistant to abrasion as well as corrosion.

The effect of erosion on the knife edge or seat would hardly ruin the jet pattern. It would cause leakage of water during the idling time between working strokes. These jet bars are under at least plant water pressure at this time. The dark streaks in the pattern are caused by dirt which comes over in the water supplied to the jet bars or the jet rings.

A mill installation always includes a spare set of jet bars. Particular attention is paid to making the changing of jet bars easy and fast. After jet bars and jet rings have been cleaned and possibly relapped several times, they can be taken to the machine shop and reground.

E. A. Randich: We find, when treating some of our alloy stainless steels, that a slight air deficiency in atmosphere results in a scale that is much looser and easier to remove than if the steel is heated in a slightly oxidizing atmosphere. We seem to produce a looser scale and not the hard type scale that the reducing atmosphere produces. However, I have to qualify this because certain other grades react oppositely. At present we have quite a large program studying these conditions. The important feature of this method of scale removal—or any good hydraulic method of scale removal—is that the system thermally shock the scale to make it crack. The scale cracks due to thermal contraction of the thin scale and not the parent metal. I believe the hydraulic-jet principle does this and should be very effective in removing scale because the velocity of the jet stream is high enough to penetrate the steam layer. Also this high velocity jet is placed at the proper angle of incidence. Apparently it is obtained by keeping the jet stream as small as possible in an area under a high pressure head.

Now we are somewhat familiar with this method of descaling. Consequently I would like to ask what effect do you get from varying the angle of incidence. Apparently your jet stream strikes the metal in a quarter-inch band at about a 55-degree angle to the surface of the strip. Also, why does the spray not diverge from the flat strip surface when it hits it rather than hug the surface as the figures show?

Robert V. Proctor: That angle of 55 degrees was arrived at as a matter of mechanical convenience. When the jet impinges at 55 degrees, the water bounces off the steel and goes in one direction. If you straighten that angle up to 60 degrees, some of that water begins to come back. You steepen it further and more water comes back and less goes forward. As far as we can discover from our experiments in the shop, it does not make any real difference in descaling whether that jet impinges at a right angle or impinges at 55 degrees. As long as there is no difference, you might as well have all the ricochet water and scale going in one direction so that you do not have to contend with them going in both directions.

We are thinking of making further studies, on our new equipment, of changing the included angle of the jet. These studies will investigate not only changing that angle but changing the angle of incidence. We are using 55 degrees on the jet bars now. We propose to try other included angles on certain stainless steels to give a little bit more gentle jet action over a little longer time in the jet zone. Also, we have indications that an even more sudden chilling will be better. Only trials will verify this.

As to the ricochet angle, you are dealing with a liquid, not a solid. If you are blowing sand or pellets, you would expect the angle of ricochet to equal the angle of the impingement. But a liquid does not do that. A liquid will practically follow the surface it hits. As an illustration, you might wash dishes for your wife some night. You hold a plate at various angles under the faucet and you will get the idea exactly. What little diverging it does have, I think, is due to the explosiveness of the steam blanket pushing it away a little. I am not sure of that, but it does not follow the surface exactly as it will under a faucet.

S. O. Evans: The author was mentioning some of the variables that entered into the descaling of the various alloys. I am interested in the problems that would be encountered in descaling hollows or billets on a mill that runs a wide range of analyses, one that might be running something in the 4000 series followed by carbon steel and possibly stainless. Would that be merely a matter of changing a jet ring, or would you also have to change your furnaces? Finally, have you been successful essentially with all the materials that you have tried out?

Robert V. Proctor: We have not been 100 per cent successful with silicon steel.

S. O. Evans: That happens to be one outside of our range.

Robert V. Proctor: We seem to have arrived at the pointing of the way, but we need to run further tests to make sure that we can repeat from day to day. In our work we are now equipped to measure and evaluate 12 different variables among which are temperature, atmosphere, speed that the workpiece travels through the jet, the jet angle, the jet divergence, and the distance the jet bar is from the work.

Descaling research has been going on continuously at our Chicago plant. Some conclusions have been pretty well established. One important conclusion is that the chemistry of the steel will determine the atmosphere in the furnace. For instance, stainless 430, a straight chrome steel, will descale with a slightly oxidizing atmosphere in the furnace. It will not descale satisfactorily when heated in a reducing atmosphere.

Stainless 302, however, which is a combination of nickel and chrome, definitely will not descale when heated in an oxidizing atmosphere but will descale when heated in a slightly reducing atmosphere.

Stainless 316 is a combination of nickel and chrome with a high molybdenum content. This combination appears to descale at neutral or a very little over on the oxidizing side.

Other steels containing chrome, nickel and molybdenum, but with molybdenum in very small percentage descale on the reducing side. Not enough work has yet been done on these chemical combinations to draw any conclusions which could be called firm. There is one firm conclusion, however, that can be stated. The heating in the furnace must produce a scale that will come off hydraulically.

Another conclusion reached is conditions of speed and other factors on each particular mill will determine the details of application of water to the hot workpiece. The combinations, for instance, that will descale one definite analysis in the form of a flat slab will be different from the combination of factors which will descale the same analysis in a form of a round bar.

Another variable has been found to add to the myriad of variables. This new variable seems to have a considerable effect on the formation of the crust of scale. It is a factor that we call "W." It is defined as the pounds of water in the air per pound of air. Research has shown that the water vapor in the combustion air is exceedingly potent in the formation of scale. It may be of interest to note that the variation in "W" encountered so far is in the nature of 18-to-1, i.e., the highest "W" encountered has been 18 times the lowest "W" encountered.

The question is raised as to whether we would have to change jet rings or jet bars. As far as research has progressed, the answer would be "No." However, the pressure would definitely have to be changed, and the water delivered to the slab per square foot would have to be changed.

It has been established that thin scales have a top limit for the amount of water as well as a bottom limit. Thicker scale, such as that formed on carbon steel, can accept surplus water without any harmful effect; but thin scale, such as that formed on the steels mentioned above, will not descale if too much water is put on them. Furthermore, they will not descale if too high a pressure is used. On the other hand, they will not descale if too little water or too little pressure is used. The theory is that using too much water and/or pressure permits the thin scale to transmit the chill to the parent metal. Thus the full shrinkage of the scale is not utilized. Time also is a factor. If the speed through the jet is fast enough that the chill does not have time to get to the parent metal, some surplus water can be accepted. The width of the band of impingement also is important because it affects the time factor. Work is continuing in an attempt to establish the parameters of the variables related to certain groups of chemical combinations.

S. O. Evans: Then a wide variety of alloys, one right after the other, could be fairly complicated?

Robert V. Proctor: No I do not think it is going to work out that way. I think you are going to find that your furnace atmosphere will be just on the reducing side until you get to carbon steel. Carbon steel in our own shop does descale on the reducing side, but in our laboratory it does not descale on the reducing side. In the shop we used oil, and in the laboratory we used gas. The carbon scales descale best on the oxidizing side—a very little oxidant not as high as 5 and 10 per cent O_2 but a little on the oxidizing side. Whether or not you would have to change your furnace for carbon steel would be a matter that would have to be tried in production.

The changing of the air-gas ratio is a simple matter because most furnaces are equipped with a valve for this purpose. There will be a period of experimentation to find the right setting of the valve for various classes of grades of alloys.

R. C. Schaefer: The author has mentioned several times the savings in volume of water. I would be interested in knowing if he has progressed far enough in strip rolling to estimate what percentage of water savings on the jets ahead of the No. 2 scalebreaker can be effected. How many of these units would be necessary to clean approximately 150 ft of bar traveling from 100 to 200 fmp?

Robert V. Proctor: There are two phases to that. We have to supply water at such a rate that it will supply so much water for every square foot of material regardless of mill speed. If you have a variable speed mill that sometimes goes 450 fpm and 200 fpm at other times, the pumpage must be subdivided so that you can pump at a rate sufficient to take care of the 450 fpm at one time and the 200 fpm at the other time. This is done by flipping switches for cutting your power packs down or up.

R. C. Schaefer: Can you estimate the savings of water, in percentage, compared to present usage?

Robert V. Proctor: We have determined that one quart per square foot of "normal" water is needed for removing furnace scale from carbon steel. Heating times cause this to fluctuate between 75 and 150 per cent of normal. For removing air scale, generally 25 per cent or one-half pint per square foot of surfaces suffices. From these figures a comparison with present use of water can be made. The saving is increased when it is considered that water supplied by power packs can be adjusted for slab width and slab speed.

R. C. Schaefer: Do I understand you will need multiple units in order to clean a 100 ft of bar moving 100 to 200 fmp? How many units would that take? I refer to your mention of "loading and unloading."

Robert V. Proctor: I would imagine we would break that up into four pumps or maybe five for flexibility reasons. When going slow, the line will use fewer pumps than when going fast, when all are needed. When you are rolling a narrow strip, you use fewer pumps. When you are rolling wide strip, you use them all. If you break it into units, hydraulic-jet descaling figures to be cheaper. ▲

Development of Atomic Power

and its possible applications to the steel industry

by Howard D. Philipp,
Mechanical Engineer,
Atomic Power Development Associates, Inc.,
Detroit, Mich.

Radioactive isotopes now help industry to produce better products at a lower cost . . . . dwindling fuel reserves make the development of nuclear power urgent.

MAN tried for centuries to uncover the secrets of the atom, but it was not until one afternoon in December, 1942, that a handful of American scientists gathered under the University of Chicago Stadium to successfully create the first nuclear chain reaction.

Intelligence reports from Germany at that time had already caused us to think of the atom only in terms of destruction, but immediately after the war thoughts of the atom changed from destruction to development of the atom for peaceful purposes. Much of the great concentration of effort since that time has been on two specific areas of development, radioisotopes and atomic power.

RADIOISOTOPES

One of the major peaceful uses of the atom is in the field of radioisotopes and their applications. The term "radioisotope" comes from two words, "radioactive" and "isotope." Few are found in nature. Our main supply comes from placing materials in an atomic reactor where there are billions of neutrons available for what you might call "exciting the atom," causing decay, and thereby creating nuclear radiation.

At the present time the country is benefiting enormously from the uses of these radioisotopes. Isotopes are atoms of an element distinguishable by their weight. Figure 1 shows five of the six known isotopes of the element carbon. The number of protons in each nucleus determines what element the atom is. Six protons indicate that this is an atom of carbon. If there were seven protons, the atom would be that of nitrogen. With five protons it would be boron. So an atom of a particular element always has the same number of protons.

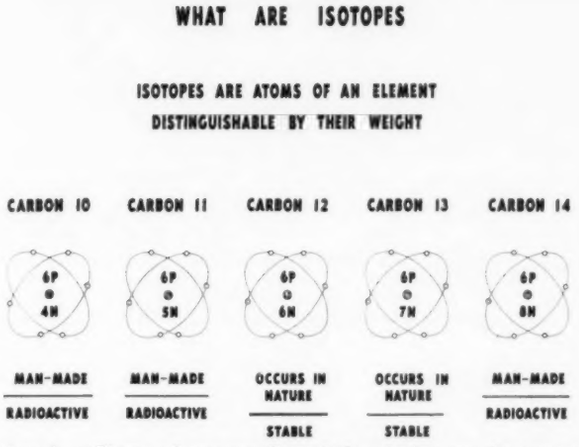


Figure 1 — Shown here are five of the six known isotopes of carbon. Note that the variation of neutrons in the nucleus is the difference between isotopes of the same element.

This is not true of neutrons, however. It is the variation of neutrons (in the nucleus) that creates different isotopes of the same element. All isotopes of a specific element have one important characteristic. That is they are essentially identical chemically, but they frequently exhibit marked differences of nuclear stability.

Carbon^{12} is the stable isotope which we come in contact with every day. If this carbon isotope were placed in a reactor, neutrons would be captured in the nucleus. It is this new combination of protons and neutrons in certain nuclei, which produce instability—so the nucleus decays towards a more stable combination at its own definite rate which cannot be changed.

When the nucleus decays, there are three types of radiation, one or more of which will be emitted during the process. The type of radiation will be dependent upon the isotope used.

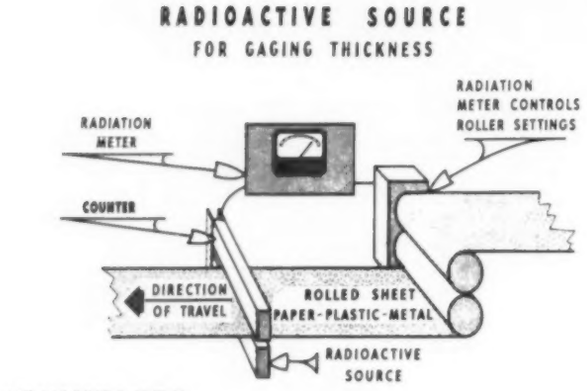


Figure 2 — This schematic drawing shows how a radioactive source is used to continuously measure material gage on a process line. This type of gage requires no mechanical contact of the material.

1. The first type is where an alpha particle is given off. An alpha particle consists of two protons and two neutrons. These alpha particles can be stopped by an ordinary sheet of paper and are not of much use in radioisotope work because of their low range. They do serve as a means, however, of making luminous dials.
2. The second type of radiation is beta particles. Beta particles are high-speed electrons which are emitted from the nucleus when a neutron changes to a proton. Beta particles can be stopped by a sheet of metal.
3. The third type of radiation is made of gamma rays which are similar to x-rays. Several inches of metal, or other heavy materials, are required to stop gamma rays. Their use in radioisotope work is also quite extensive.

RADIOISOTOPES IN INDUSTRY

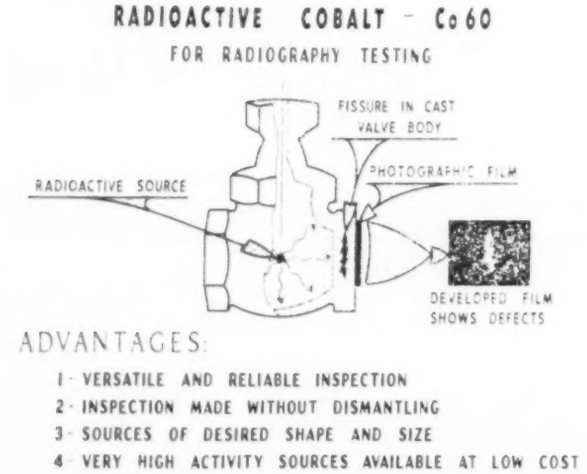
It is estimated that radioactive isotopes are saving United States industry approximately half a billion dollars per year. In many ways they are helping industry make better products not only more quickly and easily but also at lower cost. Among the invaluable devices that engineers have developed are radioisotope thickness gages (using beta emitters), which measure and control many different types of sheet materials such as metals, plastics, rubber, textiles, etc.

Figure 2 shows a thickness gage which utilizes a radioactive source. The radioactive source (beta emitter) is placed on one side of the material and a detection device on the other. The thicker the material, the less radiation gets through to the detection device.

One great advantage of the radioisotope gage is that no mechanical contact with the material is necessary, and measurements can be made continuously without stopping production.

Figure 3 shows the method of measuring thickness and defects of metal castings with radioisotopes. Because of the great thickness of material here, it is necessary to use a gamma-emitting isotope. This permits a radiograph to be made of the casting and welds to determine their soundness.

Figure 3 — Radioisotopes can be used to measure the thickness and defects of metal castings.


RADIOACTIVE COBALT - Co 60
FOR RADIOGRAPHY TESTING
FISSURE IN CAST VALVE BODY
PHOTOGRAPHIC FILM
RADIOACTIVE SOURCE
DEVELOPED FILM SHOWS DEFECTS
ADVANTAGES:
1-VERSATILE AND RELIABLE INSPECTION
2-INSPECTION MADE WITHOUT DISMANTLING
3-SOURCES OF DESIRED SHAPE AND SIZE
4-VERY HIGH ACTIVITY SOURCES AVAILABLE AT LOW COST

RADIOISOTOPES IN FOOD INDUSTRIES

It has been shown that irradiation can help to preserve food. Many foods have been irradiated for test purposes. Meat, irradiated in December, 1956, is as firm and fresh as the day it was purchased from the meat market. Radioactive gamma rays emitted by isotopes will destroy most of the bacteria in meat, vegetables and other foods. If such a package is sealed and not exposed to bacteria in the air, it will last for a long period without refrigeration.

There are several disadvantages over food sterilization. Sterilization does discolor the food, and in most cases, affects the flavor somewhat. It is believed, however, that this problem can be overcome. However, it might take ten years or more of continued research work.

ATOMIC POWER

The second major effort in the peaceful use of the atom is for the generation of electric power.

One of the most common questions asked workers in this type of work is, Why is industry so vitally interested in atomic power at this time. Industry is well aware that an abundant and low-cost supply of electric power is a major factor in continued economic growth of our country. In assuming this responsibility industry has been confronted with many problems, all of which have been carefully resolved to the best of its ability.

But today, an altogether different type of problem exists, one which has been accepted as a special challenge. It is principally a two-fold problem dealing with increased operating costs and the availability of our energy resources. Both of these are directly related to the maintaining of an abundant and low-cost supply of electric power. They are of prime importance in operating existing plants and in planning for future manufacturing capacity.

FUEL COSTS

Increased operating costs, the first part of our two-

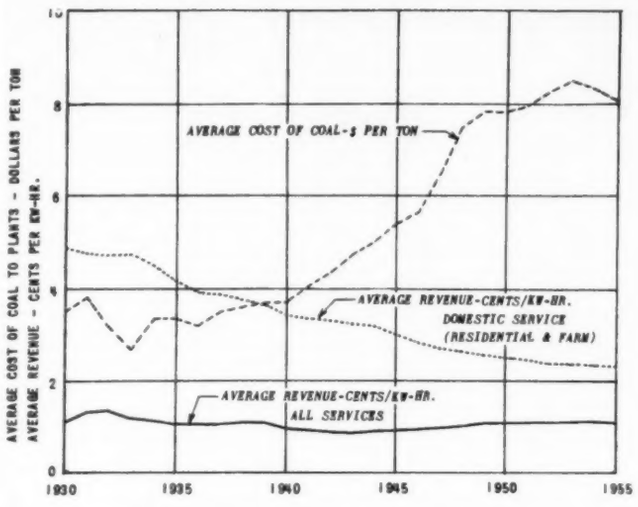


Figure 4 — This graph shows data obtained from the Niagara Mohawk Power Corp. Note how the price of coal has risen since 1930 and how the price of electrical energy has fallen since that time.

fold problem, is something we have been faced with for some time.

Figure 4 shows data obtained from the Niagara Mohawk Power Corp., but the trends shown are typical of all companies' fuel requirements within this area. Since 1930 the cost of delivered coal has risen from less than $3.50 a ton, to the 1955 level of $8.00 a ton. Other types of fuel have increased in cost in a similar manner. Almost all utilities, as well as the steel industries, are large consumers of coal. As an example Niagara Mohawk Power Corp., even with almost 40 per cent of its total energy generated by hydro-power in 1955, spent well over $27,500,000 for coal alone. It is interesting to note that in face of rising costs such as this, other economies have been affected which, in general, have resulted in a decrease in the selling price of the kwhr. This is typical of the industries today.

However, increasing difficulty in combating these rising costs can be seen. It is believed that fuel costs will continue to rise because of: (1) more difficult mining due to the increased movement of fuel from the mines as deeper operations are required; (2) higher cost of transportation; and (3) increased labor costs.

It is also believed that the maximum thermal efficiencies which can be obtained in coal-fired plants today is being approached.

AVAILABILITY OF FUELS

The second part of the two-fold problem deals with the availability of present energy resources. Up to the present time we have been dependent upon two main sources of energy to produce power: (1) the hydraulic energy of falling water, and (2) the thermal or heat energy released by the burning of conventional fuels such as coal, oil and gas.

A few years ago, the United States Atomic Energy Commission made a world-wide survey to determine the available reserves of natural fuels. The results were quite surprising.

Table I lists the types of conventional fuels (coal, oil and gas) and, below, the so-called nuclear fuels. The energy of falling water, of course, is not taken into account here. Shown in the last column are the known reserves of each type of fuel in terms of common heat energy units, British thermal units (Btu). The total heat energy reserve of the conventional fuels is 80×10^{18} Btu. It is estimated that, at the present rate of usage, this supply will last the world approxiamtely 650 years.

However, over the past 40 years, heat energy consumption in the world has doubled every ten years. Thus, it is conceivable that, if this trend continues, the estimated 650 years supply would be reduced to a mere 50 to 100 years. It is no wonder then, that we should be definitely concerned about the future of our energy resources.

Note that the known heat energy reserves of the atomic fuels are approximately 23 times that of our conventional fuels.

THE ATOM VS COAL

Why the two-fold problem of increased operating costs and availability of energy resources are of prime concern to us today is quite apparent now. In the atom is what may become an economical and plentiful fuel.

A piece of coal that weighs 2¼ lb can generate three kwhr of electrical energy in a modern steam power plant.

In contrast, a bar of uranium weighing 2¼ lb has sufficient potential energy to generate approximately 6,000,000 kwhr of electrical energy as compared to only three kwhr from an equal weight of coal. In other words, a pound of uranium is equivalent to about 1300 tons of coal.

The industrial world cannot afford to overlook this great new potential source of energy. It is believed that atomic fuel will supplement and compete with our existing fuel supply thereby solving the problem of increased costs and availability of our energy resources.

Furthermore, because nuclear fuels are so concentrated and so easily transported, we can visualize increased economy by the use of atomic heat sources in remote areas where small conventional fuel-fired generating facilities are not feasible.

ATOMIC FUELS

Atomic fuels have tremendous energy contents, but before it can be released, the nuclei must be modified. Before modification it is called a fertile material. A pure,

TABLE I

World Reserves of Fossil Fuel and Nuclear Energy

Fuel	World reserves	Total energy Btu
Coal	3482×10^9 tons	72.2×10^{18}
Oil	1241×10^9 barrels	7.6×10^{18}
Gas	560×10^{12} cu ft	0.6×10^{18}
Total conventional		80×10^{18}
Uranium	25×10^6 tons	1700×10^{18}
Thorium	1×10^6 tons	71×10^{18}
Total new fuel		1800×10^{18}

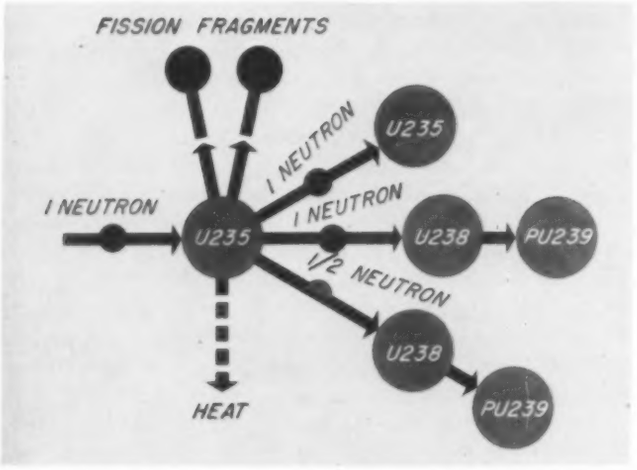


Figure 5 — This diagram shows what happens to a fertile material when it is placed in a reactor.

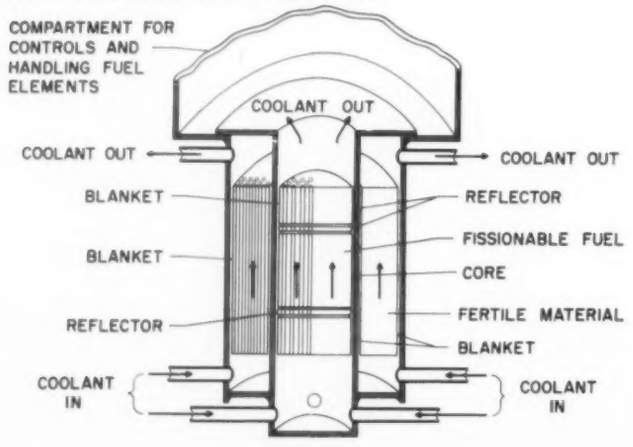
fertile material cannot be used as a fuel in a reactor, but it is capable of being modified so that it may become a fissionable fuel. All uranium, as it is found in nature, is composed principally of two isotopes. Only one part in 140 parts is ordinarily the fissionable isotope of uranium^{235}. The remaining 139 parts are the nonfissionable or fertile material, uranium^{238}.

Figure 5 describes the mechanics of fission and how a fertile material may be converted to a fissionable fuel in a reactor. A neutron released from a previous fission is captured by the nucleus of an atom of fissionable material, uranium^{235} causing it to fission. As this atom splits, two major phenomena occur. A large amount of heat is released. This is the heat energy utilized for power producing purposes. Also two to three new neutrons are released, in this case, an average of 2½ new neutrons per fission.

One neutron must be used to carry on the chain reaction. The remaining 1½ neutrons on the average, are then available for being captured by the atoms of fertile material, uranium^{238}, which cause rearranging of the nuclei into the fissionable material, plutonium^{239}. This process is commonly referred to as "artificial transmutation," i.e., the process of converting one element into another. Now this plutonium^{239} is an excellent fissionable material. As a matter of fact, it was used in the second atomic bomb dropped on Japan.

Thus, if these 1½ neutrons were fully utilized for transmuting fertile material into fissionable material, it would result in producing 1½ new atoms of fuel for each atom burned. The reactors which produce more fuel then they burn, such as described here, are referred to as breeder reactors.

Figure 6 — Shown here is a cross-sectional view of a typical atomic power reactor. This reactor, equal in size to a large rain barrel, has the same heat rating as that of a modern, seven-story high, fuel-fired boiler.



ENGINEERING THE ATOM

It might be interesting to see how atoms are engineered to obtain useful electrical kilowatts. Figure 6 shows a cross section of a typical reactor. In the center is the core which contains the fissionable fuel, uranium^{235}, and it is here that most of the fission process takes place. There are two other fissionable fuels which may be used in the reactor besides uranium^{235}. They are plutonium^{239} and uranium^{233}, another isotope of uranium. Completely surrounding the core are located blanket elements of fertile material, natural uranium. This blanket serves to absorb as many of those excess neutrons as possible to transmute the fertile material, uranium^{238}, into the fissionable fuel, plutonium^{239}. A fluid flows through passages in the core and blanket to carry away the tremendous quantities of heat generated. For the reactor shown here, the core is sufficient to generate 300 megawatts of heat and is equal in size to that of a large rain barrel. This size can be compared to that of a modern fuel-fired boiler of the same heat rating which would be equal to a building seven stories high.

The control rods, driven by servo motors, control the neutron activity of the reactor by either capturing or reflecting neutrons (as the case may be), thereby permitting control of the power level. In a fuel-fired boiler, fuel and air are injected into the burning chamber in just the proper ratio and amount to balance the power demand of the system. In a nuclear reactor the fuel is always present in the burning chamber (core of the reactor). This means that the only variable requiring control is the rate of burning of the nuclear fuel. This is determined by the neutron activity. Each time an atom fissions (splits), several neutrons are released. Positioning of the control rods will effectively govern the fate of these neutrons, i.e., determine whether they should continue splitting other atoms or be captured by the rods and rendered ineffective.

The heat from the fluid that passes through the reactor is transferred to the steam plant.

Figure 7 shows a flow diagram of a typical atomic power plant. The fluid circulated through the reactor carries its heat to an intermediate heat exchanger where the heat is then transferred to a second fluid. This, in turn, serves to generate steam in the boiler. From this point on, the cycle is similar to that of a conventional steam electric generating plant. Note that the reactor has replaced only the fuel-fired boiler and its auxiliaries. The radioactive area is surrounded by heavy shielding. The second fluid system is not radioactive and does not have to be shielded.

Circulating the coolant through the reactor appears quite simple. However, it results in major problems which are prominent in all power reactors being designed at the present time.

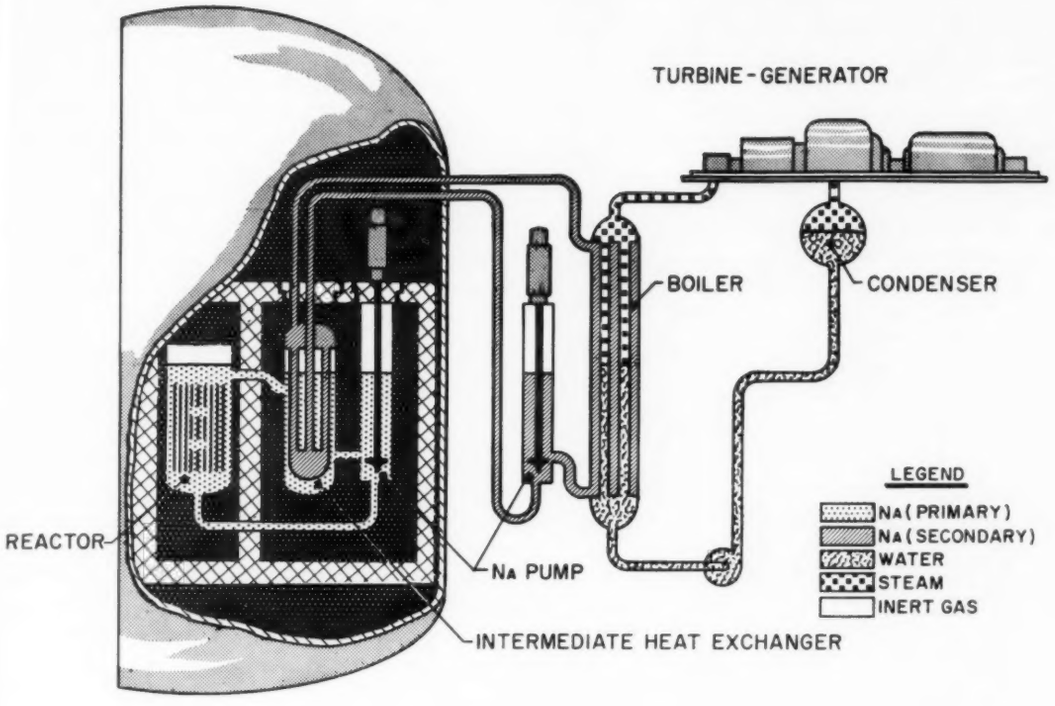


Figure 7 — This schematic is a flow diagram of a typical nuclear power plant. Note that the reactor has replaced only the fuel-fired boiler and its auxiliaries.

Figure 8 gives a comparison of sizes of the heat generating areas in a reactor core with that of a modern reheat boiler of the same capacity rating. What this means is that the same amount of heat must be removed from the small reactor core surface area as from that surface available in a conventional boiler. This, of course, produces difficult thermal stress problems not only in the fuel elements themselves but also the reactor structure. Naturally, with such a small amount of heating surface, it is necessary that a circulating fluid be used which has a high heat transfer coefficient. In the case of the fast breeder reactor plant being built in Michigan, the liquid metal sodium was selected as the heat removal fluid not only because of its relatively high heat transfer coefficient but also because of its acceptable nuclear characteristics.

MATERIALS

Corrosion and radiation damage of materials present our greatest problems in the reactor plant today. By necessity, a high degree of integrity must be placed on all reactor components and piping systems. A 15- to 20-year lifetime on all power plant equipment is desired. Because very little long-term radiation damage data is available, selection of materials must be based on limited laboratory information and the best judgment of the metallurgists.

SAFETY

Unfortunately, because of the world situation, the first dramatic application of atomic energy was directed towards destruction. If it had been first used for peaceful purposes, there would be little skepticism today as to the safety of nuclear reactors. Imagine how unsafe you would have regarded electricity had it first been introduced to the world through the use of the electric chair. Today, many reactors are in operation with excellent safety records. To my knowledge, there has never been a serious accident involving operating reactors in this country. Every possible attention has been given to designing plants that will not present a hazard to the plant operators nor to the communities. Almost all power reactors proposed have been preceded by experimental tests of this type, and it is expected that they will be as safe as a coal-burning plant. Certainly they would not be built if this were not so.

ECONOMICS

In this country at the present time, power is available at the generating station for about seven mills per kwhr as a general average. New modern steam generating plants will produce power for about six mills per kwhr. It is obvious that conditions vary so widely from country to country that atomic power may be competitive sooner in one country than in another; it is clear that atomic power, ultimately, is likely to be needed everywhere.

It is estimated that the first group of power reactors now under construction will produce power at a cost of between 10 to 60 mills per kwhr depending upon the type. This represents a large differential in cost from the six to seven mills per kwhr of our present conventional plants. The question, then, is what is preventing reduction of this cost. The principal reason is related to the lack of technology. The atom represents a new concept of engineering, and there is no question the first reactors are being physically designed with what we believe to be a great amount of conservatism. Furthermore, extra safety features are being added which probably will prove unnecessary in future reactors. Although we have attempted to use standard equipment wherever possible, much of the design requires custom-made equipment. Even on standard items each fabricated piece requires careful inspection, and new shop techniques have had to be developed. Present regulations require that large exclusion areas be provided for each plant. Consequently, about 700 acres

of land are presently being used in comparison with about 15 acres for conventional plants.

These and other additional requirements represent a first cost investment of about two to four times that of a conventional fuel-fired plant. Until these plants are built and operated, how to reduce costs will remain unknown.

Besides the high first cost investment in nuclear power plants, operating costs are also necessarily excessive at the present time. The fuel cycle itself is probably the major operating cost. The solid fuel elements must be removed periodically much the same as the ash in a boiler although not as frequently. The cost of reprocessing and refabrication of these fuel elements, once removed, represents a very high cost figure. Until new techniques are developed in the nuclear fuel cycle, the operating costs will remain excessive. Some success has been attained in the development of a fluid fuel rather than solid fuel elements. The fluid fuel is circulated during operation of the reactor

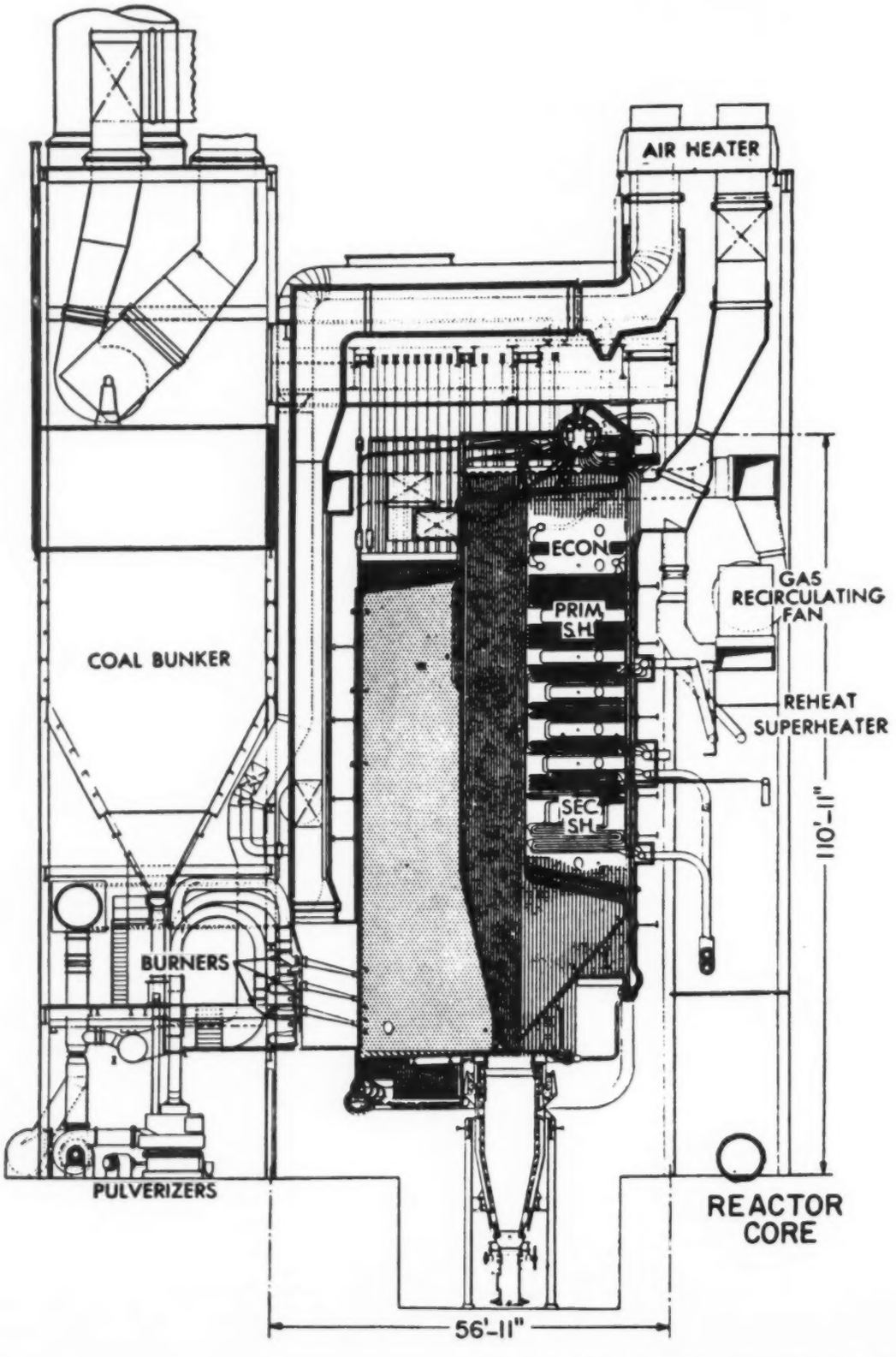


Figure 8 — The purpose of this drawing is to give a pictorial comparison of the sizes of the heat generating area of a reactor core and that of a modern reheat boiler with the same heat capacity. Because of the great difference in these areas, difficult heat transfer and thermal stress problems are encountered in reactors and must be overcome.

and does show promise of being a more economic source of nuclear power.

It must also be pointed out that the fuel cost in a conventional plant represents less than 20 per cent of the total cost of producing and distributing electricity. With such a small percentage of the total operating cost involved in fuel expenses and with the factors mentioned previously, it is apparent that only a very small margin is available to work with to make these nuclear plants competitive with coal, oil, and gas.

PROGRESS IN POWER REACTORS

Since the Atomic Energy Act was amended in 1954 to permit private industry to construct, own and operate power reactors, a number of industrial groups have been carrying on their own development efforts. At the present time there are more than 16 such groups which are active. Manufacturers of power equipment, chemical firms, electric power companies, engineering and construction organizations, and many others comprise these different groups.

Fourteen power reactors are either under construction at the present time, or have been proposed, which will total about 1,200,000 kw of capacity for civilian use by 1962. Included in these fourteen power reactors are eight different types of design with each group pursuing what they believe to be a practical approach to the commercial use of atomic energy for power generation. As a result, within six or seven years, the United States should have a full working knowledge with valuable experience on many types of power reactors.

THE FUTURE

Now let us take a look at the future. Engineers, industrialists and responsible governments all have begun to be concerned about energy resources. In this country especially, many studies have been made in the last few years seeking to discover accurate information on fossil fuel reserves and foreseeable fuel needs. The result of these studies indicate that the accessible fossil fuel reserves will probably be exhausted during the first part of the 21st century.

The most promising is the outlook for nuclear fuels. Their capacity to breed additional fuel, their extremely high energy output from small quantities, and their relative abundance seem to put nuclear fuels well out in front as the most promising source of energy for the future.

It seems possible that certain type or types of stationary atomic power plants will produce economically competitive power within the next ten years, i.e., they will approach an electrical generating cost of six to seven mills per kwhr. We believe the turning point in the evolution of economic nuclear power will come some time after 1962 when the many nuclear power plants, mentioned previously, will be in operation. Certainly, if the development of nuclear energy continues at the same pace as it has over the past five years, and the technology continues to gain, as it has in the past, from the construction and operation of plants; it will provide much of the necessary information and impetus to establish new concepts and limits in the design.

It has been predicted that during the next ten years the present electrical generating facilities will have to be doubled in order to meet the growing demands of the consumers. Some of the electric companies are planning to install large nuclear power plants some time during that period.

Small atomic power plants present a different picture. It is doubtful that these small plants can be built to produce economic power at any time in the near future. The cost of operating nuclear power plants is based to a large extent on their fixed charges. Although small plants are expensive, a relatively small addition to the capital investment would permit a very large increase in capabilities. In the foreseeable future, then, power would be most effectively generated at large central stations.

At this time it does not appear feasible that atomic energy could ever be utilized directly for furnace operations in metal refining or fabricating processes. Although high temperatures could be available in a fission process, there are definite metallurgical limitations as to the maximum temperatures which could be tolerated by the fuel containers and vessels. Furthermore, possible contamination of the process caused by escape of fission gases and other radioactive products could present a serious problem. It is possible that atomic energy could supply the heat necessary for certain auxiliary operations such as for gas circulation, steam and other services.

Because of its inherent characteristics, nuclear fuel cannot be used directly in small machines such as cars, trucks or tractors. It is doubtful, at least in our time, that it could furnish economical fuel for civilian airplanes or ships, except possibly, very large ones. There has been much talk regarding nuclear locomotives. However, it might prove more advantageous to move trains by electricity produced in nuclear central stations.

SUMMARY

1. It is estimated that radioactive isotopes are saving industry over half a billion dollars per year by helping them make better products not only more quickly and easily but also at lower cost.
2. Because of the vast new source of heat energy which it makes available, nuclear energy does hold the promise of a more abundant supply of electricity.
3. Although adequate energy resources exist to meet the world's need for the immediate future, the need for the development of nuclear power is urgent in order to help conserve the dwindling fuel reserves.
4. A tremendous amount of research and development must be done before nuclear energy can serve as a competitive fuel to oil, gas and coal.
5. Nuclear power plants will be as safe as any other normal industrial activity.
6. Because of the high cost of nuclear reactors and the fact that the major cost of producing and distributing electricity does not result from fuel expenses, it is probable that the successful development of nuclear fuels will not result in large savings to the consumers, at least for the present.
7. Due to the small incremental captial investments with increasing plant size, power will be most effectively generated at large central stations.

8. Because of metallurgical limitations and possible radiation hazards it does not appear that atomic energy will be utilized directly for metal process applications.

Discussion

PRESENTED BY

HOWARD D. PHILIPP, Mechanical Engineer, Atomic Power Development Associates, Inc., Detroit, Mich.

Member: What relation has "heavy" water to the nuclear reactor process?

Howard D. Philipp: "Heavy" water is water which contains the heavy isotope of hydrogen, deuterium instead of the ordinary hydrogen isotope. It is widely used as a coolant in reactors to slow down neutrons. This neutron moderating effect increases the fission reactions. Neutrons are slowed down when they collide with atoms of light elements such as hydrogen and carbon, two common moderators. The present high cost of heavy water limits greater use of it.

Member: Can you give us an example of the temperature levels reached in a reactor?

Howard D. Philipp: If it were not for metallurgical limitations, the temperatures obtainable would be many thousands of degrees. However, with our present day technology, the maximum temperatures would be limited to that which the fuel housings could tolerate. For example, a ceramic housing could tolerate a maximum reactor temperature of about 2000 F while a metallic housing would be limited to about 1200 F.

Member: Can power be generated more cheaply in the boiling water type reactor than other types of reactors?

Howard D. Philipp: It has been claimed that the boiling water type reactor can produce power at costs competitive with our conventional fuels. That has to be proved first. None of the initial power reactors, including the boiling water reactor, is expected to produce competitively priced power.

Member: How soon can electric power be generated directly from a nuclear reaction, i.e., by-passing the thermal to electric energy conversion?

Howard D. Philipp: Back in 1954 a large corporation announced that they had successfully developed an atomic battery that converted nuclear energy directly into electrical energy. Because of its low conversion factor, it should be considered mainly as a low power source for electronic applications.

With the present conversion factor obtainable on these batteries, it has been estimated that the combination of a sufficient number to operate a refrigerator would cost $20,000,000. It does not appear too feasible, at least at this time, to consider the use of the atomic battery for power production on a large scale basis.

Member: What is the economic "break even" point on size of reactors?

Howard D. Philipp: It is difficult to say what minimum size the reactor should be to reach competitive costs with conventional plants. Our lack of design and operating technology today prevents us from stating a specific "break even" point. However, we do know that first costs for small plants are expensive and that a relatively small addition to the capital investment would permit a very large increase in capabilities. For this reason a general statement was made in the paper that "in the foreseeable future, power would be most effectively generated at large central stations." One group just recently made a statement that they plan to build a 60,000-kw plant, and that they expect it to produce competitive power.

However, for this present generation of power reactor construction, you will find in general that the electrical outputs will be on the order of 100,000 kw or larger.

Member: What is the English announcement about to be made concerning a new process?

Howard D. Philipp: It is probably utilization of the fusion process as a controlled heat energy source. It is purely a guess.

Member: Is Great Britain or Russia ahead of us in atomic power development?

Howard D. Philipp: From the data available, I would say that the U. S. is ahead in atomic power development. We have either built or are in the process of building more than eight different types of reactors. Design technology cannot be obtained nor proved without actually operating reactors. We do not believe that other countries are as advanced as we are in this most important phase.

Member: What does the cost of 10 to 60 mills per kwhr apply to?

Howard D. Philipp: It applies to the cost of producing electric power at the bus bar and takes into account the fixed charges and operating costs. Research costs are generally not included in arriving at these figures.

Member: Are we limited to the number of fuels that can be used in the fission process?

Howard D. Philipp: Yes. The fission process can be accomplished only with the heavier elements having fissionable nuclei. They are plutonium^{239} and two isotopes of uranium, U^{235} and U^{237}.

Member: What is the difference between the fission and fusion processes?

Howard D. Philipp: In the fission process the nucleus of the atom is split into two parts releasing a large amount of radioactivity and heat. Fission reactions occur only with heavy elements such as uranium and plutonium.

In the fusion process the nuclei of atoms are joined to form a heavier nucleus. This is accomplished under conditions of extreme heat (millions of degrees). If two nuclei of light atoms fuse, the fusion is accompanied by the release of a great deal of energy. It is believed that the energy of the sun is derived from the fusion of hydrogen atoms to form helium.

Member: Is the information obtained by the private nuclear power research or study groups available?

Howard D. Philipp: A very small part of power reactor information is of a classified nature. Therefore, in most cases, it is likely that information would be available. Personal contact with the appropriate organizations would determine the existence and availability of the specific information you desire. ▲

Recent Lubrication Experiences in the Sparrows Point Plant

by Thomas A. Bessent,
Assistant Lubrication Engineer,
Bethlehem Steel Co.,
Sparrows Point, Md.

. . . . properly designed lubrication systems reduce maintenance . . . . a wide variety of problems must be solved by lubrication engineers when correcting lubrication system shortcomings of existing equipment . . . . solutions to some typical lubrication problems are given . . . .

LUBRICATION engineers in modern, fully integrated steel plants are concerned with a wide variety of problems. These problems vary in complexity from the recommendation of the lubricant for a ¼-hp gear reducer to the design of a circulating oil system of 12,000-gal reservoir capacity for a rolling mill. For the successful apprehension and solution of these problems, the lubrication engineer must enjoy the confidence and co-operation of all the plant concerned with lubrication, including master mechanics, mechanical foremen, millwrights, oilers, and last, but not least, the operating personnel.

OPEN HEARTH CHARGING CAR LUBRICATION

The need for a better lubrication program for the plant's 630 open hearth charging cars had long been recognized by those concerned. The 480 cars of original design are equipped with a spiral-wound roller bearing with a bronze thrust plate and a retainer plate containing a felt to retain the lubricant. As shown in Figure 1 the lubricant is pumped into the bearing through a grease fitting on the end of the bearing box. Retention of lubricant and the exclusion of foreign matter have proved difficult on these bearings because:

1. Wear on the thrust plates is caused by sidewise movement of the axles. The retainer plates and felts also become worn. Many of the tracks on which the cars are pulled are rough and off gage. This increases axle movement.

2. Heat from the open hearth furnaces, particularly in summer, softens the grease and increases the tendency for the grease to run out of the bearings.

The cars were originally greased with hand pumps (Figure 2) using a No. 1 soda-soap grease. An attempt was made to grease every car once a month, but this proved to be difficult because the cars are scattered throughout the four stockyards, the four open hearth shops, the limestone bins and on any of the connecting tracks; and in cold weather it was necessary to warm the

Figure 1 — This cross section of a bearing box of an open hearth charging car shows its provisions for bearing lubrication. Softening of the grease from exposure to the heat of the open hearth shop and wearing of the grease retainer and plates from thrust loads, which are caused by out-of-line tracks, made monthly greasing of these bearings imperative.

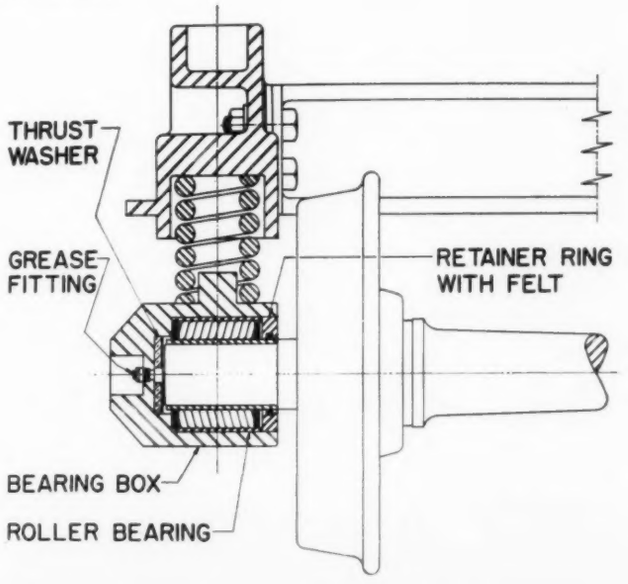


Figure 2 — Originally the charging cars were greased with hand grease pumps as shown here.

grease either in the oil house or in the field. Many cars were missed with this method of lubrication. To avoid bearing failures the lubricant which is lost because of worn seals and softening of the grease must be replenished during every lubrication period.

A greasing station, the first of two, was installed at the No. 2 open hearth limestone bins in the early months of 1957. This site was selected because most of the charging cars get on this track in the course of a month. A high-pressure grease pump shown in Figure 3 supplies a 260-ft long, $1\frac{1}{4}$-in. extra heavy pipe header

Figure 3 — To insure monthly greasing, this high-pressure grease pump, housed in a steam-heated house, was installed at the open hearth limestone bins.

on both sides of the limestone bins. Outlet valves are located every 50 ft at the end of a $\frac{1}{2}$-in. drop. As shown in Figure 4 the pipe header is steam traced and insulated to facilitate pumpability in cold weather. Grease is forced into the fitting in the bearing box through hoses equipped with a control valve located at each outlet as shown in Figures 5 and 6. The car frames are marked with paint as they are greased. Three colors are used—a different color designates each greasing period. The numbers of the cars lubricated are recorded daily. Bearing failures have been greatly reduced since the greasing station was placed in operation.

The 150 new cars, furnished for No. 4 open hearth, are equipped with tapered roller bearings and labyrinth seals. Figure 7 shows the bearing design. The new greasing station at No. 3 and No. 4 open hearth limestone bins is similar to the one at No. 2 open hearth. However, an electric heating cable has been provided in lieu of a steam tracer on the headers.

HOT STRIP MILL FURNACE CHARGING TABLE

The furnace charging table rolls in the 56-in. hot strip mill, shown in Figure 8, are equipped with roller bearings which were originally lubricated with hand grease systems. In the early months of 1954, considerable trouble was experienced with the tables because of lubrication difficulties. The turning of the rolls was sluggish, delays resulted from the slow-down of the table, and motor overloads kicked out. In spite of the fact that the bearings were individually greased on repair days with a portable electric grease pump, bearing failures occurred on the average of one a month. Changing a bearing was costly and time consuming. The lead lines to the bearings were filled with carbonized grease.

Temperatures of the bearings ranged from 210 to 350 F. Originally, the tube lines were exposed to the radiant heat of the furnace for almost the entire depth of the table girder as shown in Figure 9. Other considera-

Figure 4 — The high pressure grease pump supplies two insulated, steam-traced headers which are located on the sides of the limestone bins.

Figure 5 — Fifty-foot sections of grease hose shown here are connected to each outlet on the header.

Figure 6 — This workman has connected the control valve of one of the hoses to a grease fitting and is greasing its bearing.

tions were eliminated in favor of drilling the table girder approximately 12-in. below the bearing as shown in Figure 10. This reduced to a minimum the distance that the tube lines are exposed to the radiant heat. A grease system that would furnish smaller quantities of grease at more frequent intervals than is possible with a hand system was deemed necessary because of the temperatures encountered. An automatic, single-line, one-way grease system was installed in July 1954 to lubricate the 48 idler bearings opposite the furnaces. Figure 11 shows the grease pump. The lubricant used is a No. 2 lithium-base grease. There have been no bearing failures since the system was installed. A similar system has subsequently been installed in the 68-in. hot strip mill.

CENTRALIZED OIL SYSTEM FOR HIGH-SPEED NAIL MACHINES

In October, 1954, fourteen high-speed, precision-built nail machines shown in Figure 12 were placed in service in the nail mill. For lubrication each machine was equipped with a self-contained oil system consisting of

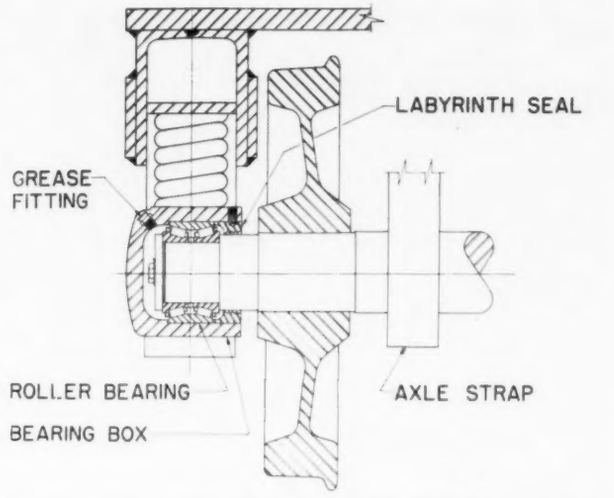


Figure 7 — The new open hearth charging cars are equipped with double-row, tapered-roll bearings, one of whose cross sections is shown here.

a five-gallon reservoir, a belt-driven pump, one magnetic and three automotive cartridge-type filters, together with distribution manifolds and valves. Two cartridge-type filters were normally in use, and the third one was put in service through a by-pass relief valve in the event the other two became clogged. A pressure switch is incorporated in the oil line to the eccentric shaft. The function of this switch is to stop the machine if the oil pressure drops to a low pre-set figure. A coated wire is used in the nailmaking process, and one of the functions of the coating is to prevent excessive wear of the cutters during the nailforming process. Some of the coating leaves the wire as the nails are formed and contaminates the lubricating oil in the machines. Under these conditions filter cartridge life was short. Frequent shutdowns to change cartridges and clean out the oil reservoirs were necessary. This operation required from two to three hours per machine. Both filter and oil costs were excessive.

There were other lubrication difficulties during the early months of operation in addition to this. They re-

Figure 8 — The bearings of these 56-in. hot strip mill charging table rolls were originally but unsuccessfully lubricated by hand greasing systems.

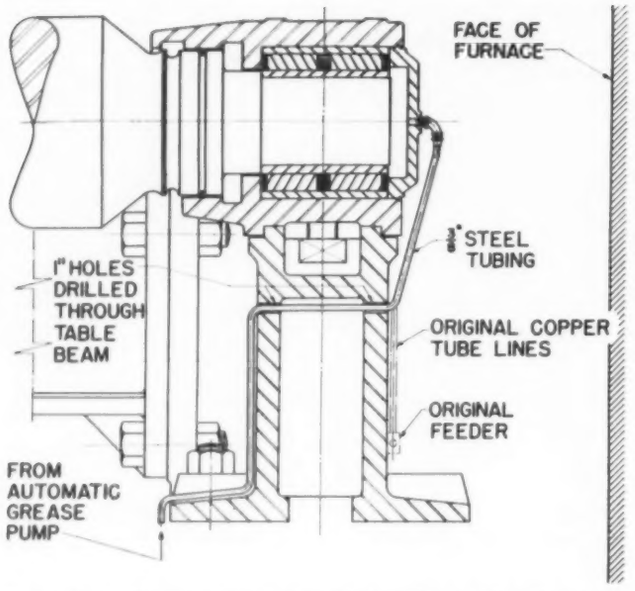


Figure 9 — This sectional view of charging table rolls shows the original tubing, which exposed the line to the radiant heat of the furnace for the entire depth of the table girder, and the present tubing arrangement which minimizes this exposure.

sulted in considerable downtime and less production than had been expected from these machines. These difficulties included:

1. Frequent stoppages of the machines caused by low oil pressures. Low oil pressures were the result of two factors: (1) Even with the needle valves set at the minimum permitted by the machine manufacturer, the capacity of the pump would maintain the oil pressure only when filters were clean. As filters became dirty, oil pressure dropped and caused machine stoppages. (2) The machines generated considerable heat during operation, and the heat was transferred to the oil and lowered its viscosity. This, in turn, lowered the oil pressure. (Machine housings would heat to approximately 150 F.)

2. The formation of excessive oil vapors, which, in addition to depositing oil on the nails, created a health and safety problem to personnel in the nail mill.

Figure 10 — Rerouting of the lubrication tubes was accomplished by drilling holes, shown here, in the table girder.

After considerable study by the mechanical and operating people concerned, it was decided that a central oil system was a necessity if the nail machines were to operate at their designed capacity. The system was designed, approved and installed in September, 1956. It consists of a storage tank, two pumps, two filters and an oil cooler shown in Figure 13. Because space for an oil cellar was not available, it was necessary to install a sump tank with pumps to return the oil to the storage tank. A covered trench was installed in front of the machines for the pressure and return lines. Strainers with 90-mesh screens were installed in the sump tank and the storage tanks to filter out solid particles and as much of the wire coating as possible. The storage tank was made in two compartments: one side having a good batch of oil held in reserve with the other side used for operation. When the operating batch of oil becomes contaminated, tanks are switched to permit settling of the contaminated oil. Operation was begun with the use of

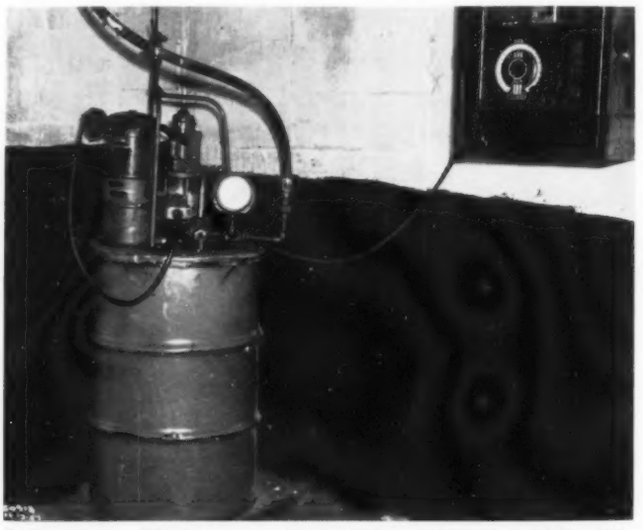


Figure 11 — The hand grease system for the table rolls was replaced by an automatic, single-line, one-way grease system. Its electric-hydraulic grease pump and timer are shown here.

Figure 12 — The many bearings, slides and cams of these high-speed nail machines require good lubrication. Part of the coating on the wire that is used for making nails contaminated the lubrication and made the occurrence of required time consuming filter cartridge changes very frequent.

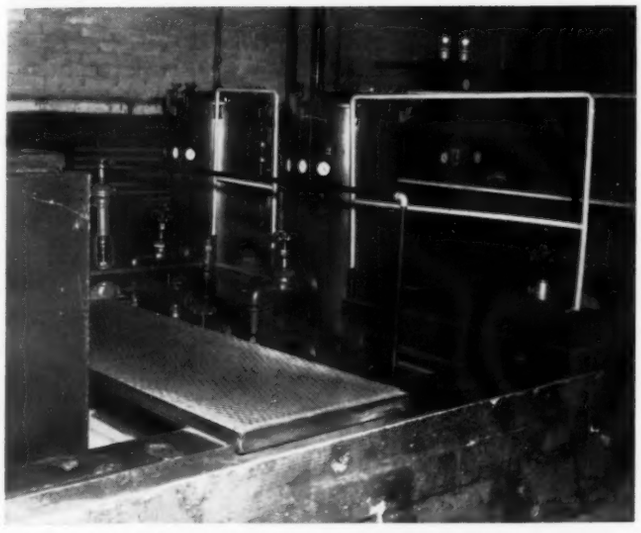


Figure 13 — Shown here are the storage tank, two pumps, two filters and the oil cooler of the central oil system installed for the nail machines.

two-micron particle selection size filter cartridges. However, these cartridges lasted only 32 hours. Fifteen-micron cartridges were then selected, and cartridge life has proved to be more reasonable (six months).

The advantages resulting from the installation of the central oil system are:

1. More efficient oil filtration has resulted, and cleaner oil is supplied to the machines.
2. Downtime due to low oil pressure has been eliminated.
3. The machines run cooler.
4. The cost of oil-system maintenance has been greatly reduced. $400.00 per yr vs the $2,896.00 per yr original cost.
5. Oil consumption has been reduced by an average of one pint per ton of nails.
6. Oil vapors have been noticeably reduced.
7. Maintenance of 14 individual oil pumps has been eliminated.
8. The cleaning cycle of the nails has been reduced 25 per cent.
9. The nail mill operating personnel advise us that the efficiency of the machines has shown remarkable improvements.

SINTER MACHINE PALLET WHEELS

No. 2 sintering strand was placed in operation at Sparrows Point in December, 1952, with No. 1 strand following in January, 1953. The No. 3 and 4 strands went into operation in 1956 with No. 5 and 6 strands following in 1957. Figure 14 is a view of one of the sintering machines. The lubrication and maintenance of the pallet wheels of the machine was a problem almost from the outset because of the heat, the abrasive materials present and the design of the wheels. The principal parts of the wheel are the shaft, two tapered roller bearings, adjustment nut, wheel body, end cap with grease fitting, and a synthetic rubber spring-leaded seal (Figure 15).

The wheels are lubricated with a high-pressure grease pump, while the machine is in operation. Grease added to the grease fitting is forced through the bearings and

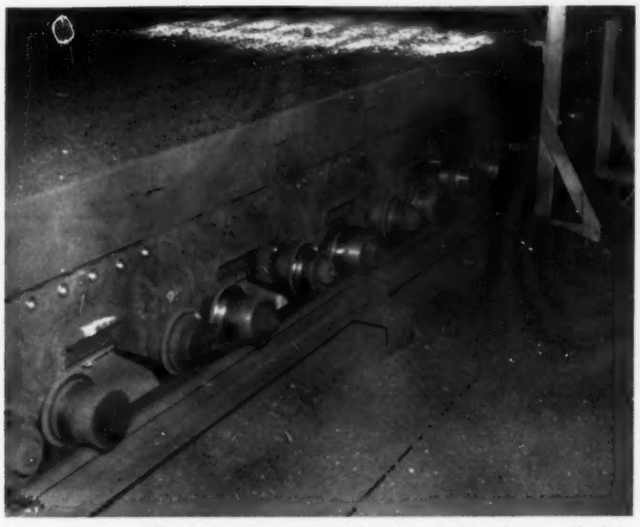


Figure 14 — Maintenance of the wheel bearings of this sintering machine was a problem because of the excessive wear and abrasive material present and the design of the bearings themselves.

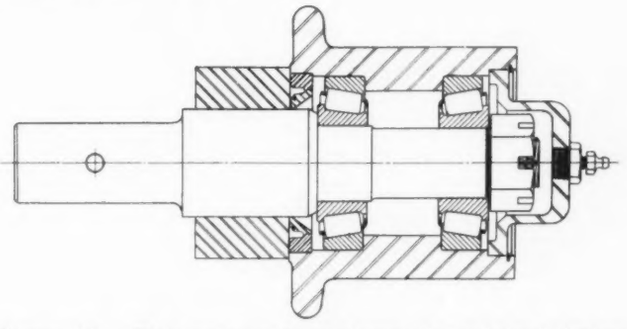
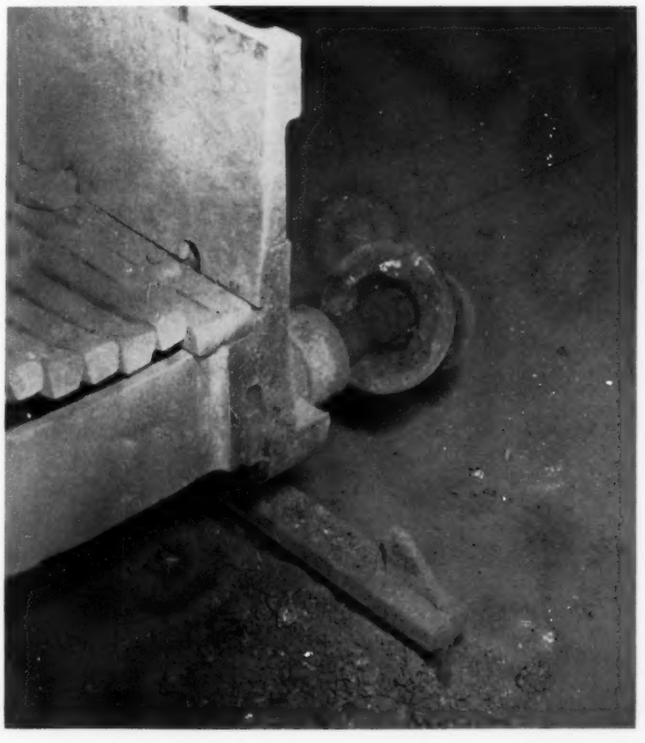


Figure 15 — This cross section shows the original design of the pallet wheel bearings of the sintering machine. This design required lubrication two or three times a week.

Figure 16 — After three or four months service, sintering machine pallet wheel bearings of the old design failed like the one shown here. Sinter got inside the bearing seals and caused the failures.



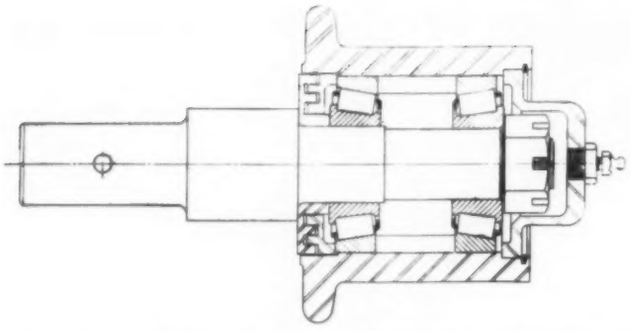


Figure 17 — This cross section shows the labyrinth type bearing seal of the new design of the sintering machine pallet wheels. Lubrication has been reduced to once a week, and no failures have occurred to date.

out through the seal. Originally a bentone-base grease was tried but was found not suitable for the application. A lithium-base grease was then tried and proved more satisfactory. The pallets were greased two to three times per week.

After the first three to four months of operation, bearing failures began to take place. Figure 16 shows a typical failure. Presence of sinter inside the bearings proved that the seals were not holding up. They were found in all stages of failure with broken springs and lips becoming brittle and eventually falling out. Bearing failures were most prevalent on the rear wheels because the seal is only $\frac{3}{8}$-in. from the pallet side, compared to $2\frac{7}{16}$-in. in the case of the front wheels.

Each machine contains 128-four-wheel pallets. Failure of any one of the wheels necessitates the removal of a pallet from the machine. The wheels had to be rebuilt immediately in order to keep an adequate supply of spare pallets on hand. Three to four repairmen were kept on the job 8 to 12 hr a day. They could rebuild the wheels on approximately four pallets in eight hr. The cost of bearing and seal replacement was $10.00 per wheel.

A number of different types and compositions of seals were tried in an effort to eliminate the failures. Prior to the start-up of No. 3 and 4 strands, rings of sheet packing were inserted between the pallet casting and the wheel. These rings were supposed to protect the seals from the heat and sinter. In spite of the above trials, the wheel failures continued.

Representatives of the bearing manufacturer were called in to discuss the problem. A steel labyrinth type seal was proposed by the manufacturer and approved by all concerned. It is shown in Figure 17. Twenty pallets equipped with this type wheel (80 wheels) were placed in service in January, 1957, for a trial on lines 3 and 4. The new No. 5 and 6 machines, which were placed in operation in June and July, 1957, respectively, were equipped entirely with labyrinth seals. To date approximately 300 pallets (1200 wheels) on the older lines 1 through 4 have been equipped with labyrinth seals. There have been no failures to date on wheels equipped with this seal. The lubrication interval has been reduced to once a week.

Figure 18 — When this 500-ton forging press had cut rings of hydraulic packing on its main plunger and water was hydraulic medium, excessive wear made twice-a-week repacking a necessity. Replacing the original cylinder bushing with two bushings and the original, badly-scored plunger with a chrome-plated one, redesigning the packing gland for a set of molded "V" packing, and using a mixture of water and oil as the hydraulic medium have resulted in maintenance-free operation to date.

BLACKSMITH SHOP FORGING PRESS

The packing on the main plunger of the 500-ton forging press in the blacksmith shop proved to be a problem several years ago. It was necessary to repack it as often as twice a week. Frequently it was necessary to shut down the press before the end of the day because of excessive leakage. The plunger has a $16\frac{1}{2}$-in. diam and was packed with cut rings of hydraulic packing. Excessive wear often made it necessary to replace the cylinder bushing and the packing glands.

Figure 19 — This is a closeup of the plunger of the forging press.

Water was the hydraulic medium which forced the plunger down during the forging operation. The maximum pressure which can be developed by the press is 11,120 psi when 130-psi steam is used in the large intensifier cylinder (ratio of intensification—85½).

The original 6²¹⁄₃₂-in. long cylinder bushing was replaced with two bushings each 12 in. long. This was done to keep the cylinder from cocking. The packing gland was redesigned for a set of molded "V" packing. A chrome-plated plunger replaced the original badly-scored plunger.

The new bushings, plunger and packing gland were installed and the fluid in the hydraulic system was changed from plain water to a 30 to 1 mixture of water and soluble oil. It was felt that the soluble oil would provide better lubricating and anti-rusting properties. The press was placed in service in October, 1953, and the same set of "V" packing is still in service after 39 months with no sign of leakage. A packing lubricant is applied daily to the plunger. Figures 18 and 19 show the press.

SUMMARY

In each of these projects the corrective measures that were taken included either:

1. A change in the method of application of the lubricant.
2. A change in the frequency of the application of the lubricant.
3. A change in the sealing or packing of a unit.
4. A change in design of the equipment.

Considerable time and expense have gone into each of these jobs. The role of the lubrication engineer does not end when a change is made. The performance of each of these projects must be followed to determine if the maximum benefit is derived from the lubrication system, grease system, or other change. This is done by checking the life of various machine elements, bearings, slides, seals, etc. Improvements developed in the field are incorporated in the original design of new equipment.

Discussion

PRESENTED BY

JOHN F. O'HEAR, Assistant Superintendent of Maintenance, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

NORMAN BRACHT, Lubrication Engineer, Alan Wood Steel Co., Conshohocken, Pa.

THOMAS A. BESSENT, Assistant Lubrication Engineer, Bethlehem Steel Co., Sparrows Point, Md.

John F. O'Hear: I would like to know the type of grease used on the furnace tables, and I would also like to know how far away from the furnace the tables are. Have you attempted to use a deflector or heat shield to protect the bearings?

Norman Bracht: Safety in a steel plant is everyone's business. The safety engineer is there to organize it and help out. I think it is the same way with the lubrication engineer. We lubrication engineers must get across that lubrication is everyone's business, including operators and other maintenance people, because everything in a steel plant that moves requires lubrication of some type. I have seen example after example where we, as lubrication engineers need the help and assistance of the engineering department, design engineers, and the vendors, who are selling the equipment and materials that we use. I think that is one of the key things that we, as lubrication engineers, in the steel industry have to do. We must get everyone in the steel industry lubrication conscious.

Thomas A. Bessent: Mr. O'Hear asked about the type of lubricant that we use in the hot strip mill charging table. We use a high-temperature, lithium base grease there. The distance from the furnace to the tables is approximately four feet.

As far as insulation is concerned, we tried some asbestos sleeves, but, they did not prove too successful. What we have gone to on a similar installation is to use aluminum shielding with an air space between the shield and the tubing. This has proved to be more successful. ▲

ROLL DESIGN
and
MILL LAYOUT

By **ROSS E. BEYNON**

Cloth bound . . .

128 pages . . .

303 illustrations . . .

Price: To AISE Members . . $3.00
To Others $5.00

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 Empire Building Pittsburgh 22, Pa.

500-TON

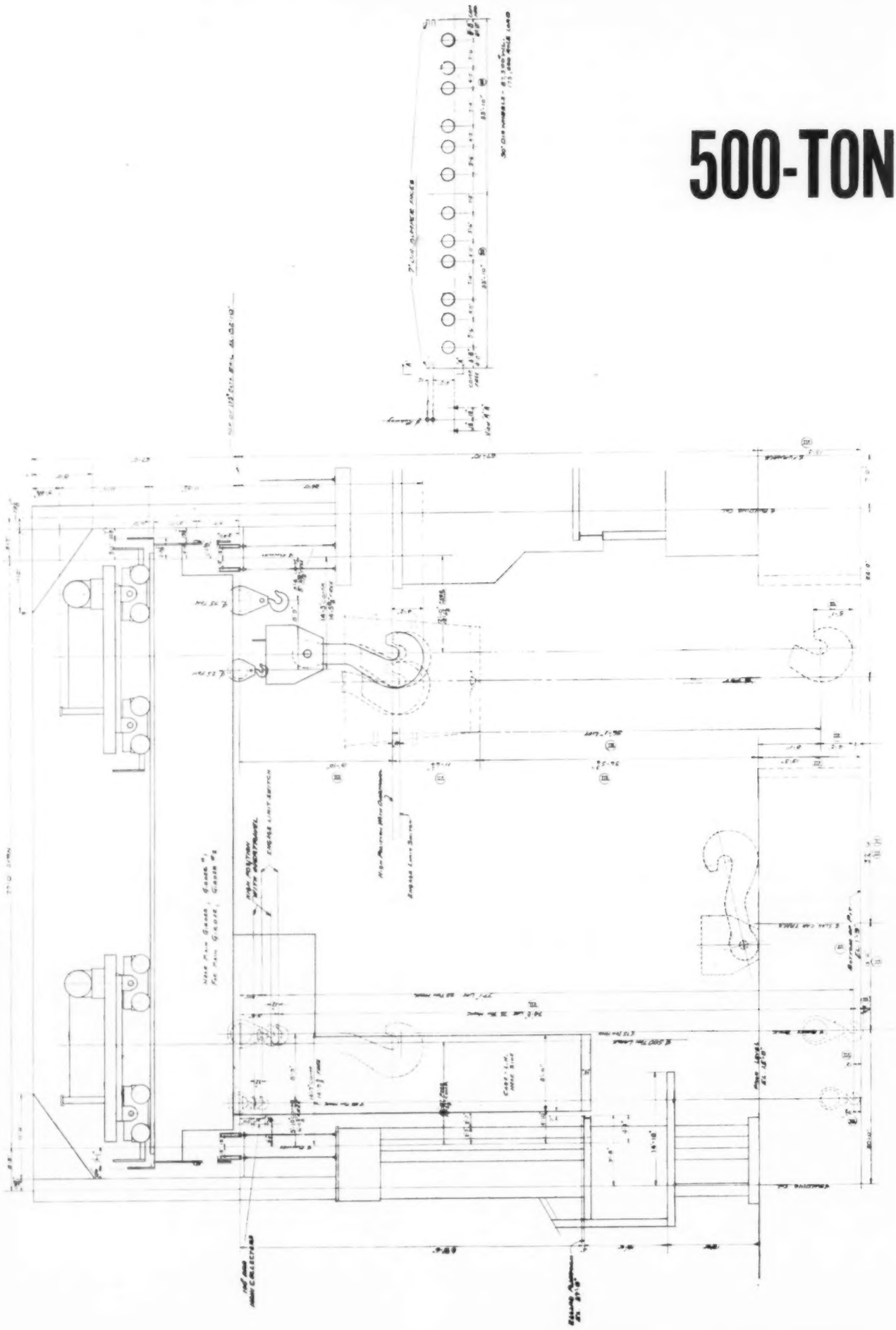


Figure 1 — This outline section through the open hearth building shows the over-all dimensions of the 500-ton ladle crane and the building.

Hot Metal Ladle Crane

Complete redesign was necessary to increase the capacity of hot metal ladle cranes to 500 tons.

by Charles F. Simmers, Vice-President—Engineering, The Morgan Engineering Co., Alliance, Ohio

IN the early days of the steel industry cranes were crude, slow and had small capacities. However, there has been continuous growth in capacity, span and speed of cranes. Technical development has been rapid.

Until 1956 the largest hot metal ladle cranes were in the 400 to 450-ton range. The design of these cranes was stretched from the 300-ton base cranes developed about 15 years ago.

In 1955 we were approached by a large eastern steel company to design and build three 500-ton capacity hot metal ladle cranes for a new open hearth shop. In analyzing this problem it was found that the overstretched, 400-ton, hot metal ladle crane base could not be used because the customer advised us that they expected, in the future to handle loads heavier than 500 tons. A new base had to be developed.

Our first study showed need for 32 single wheels on the bridge. This made the crane 79 ft-2 in. wide end-to-end of bridge bumbers. Each wheel had to carry a

Figure 2 — The 500-ton ladle crane is shown positioning a large ladle for lining inspection. The size of the workmen at the ladle opening shows the relative size of the equipment and building.

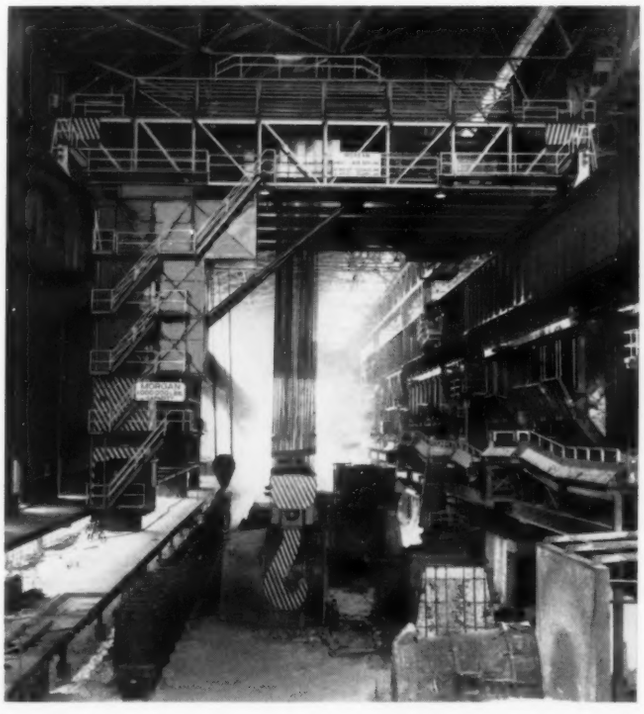
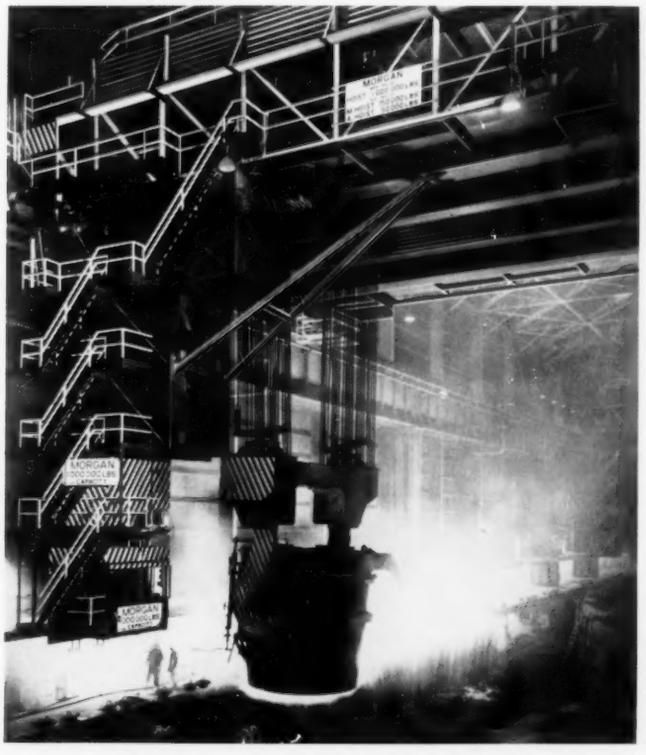


Figure 3 — The ladle crane is positioning a ladle over ingot molds for pouring.



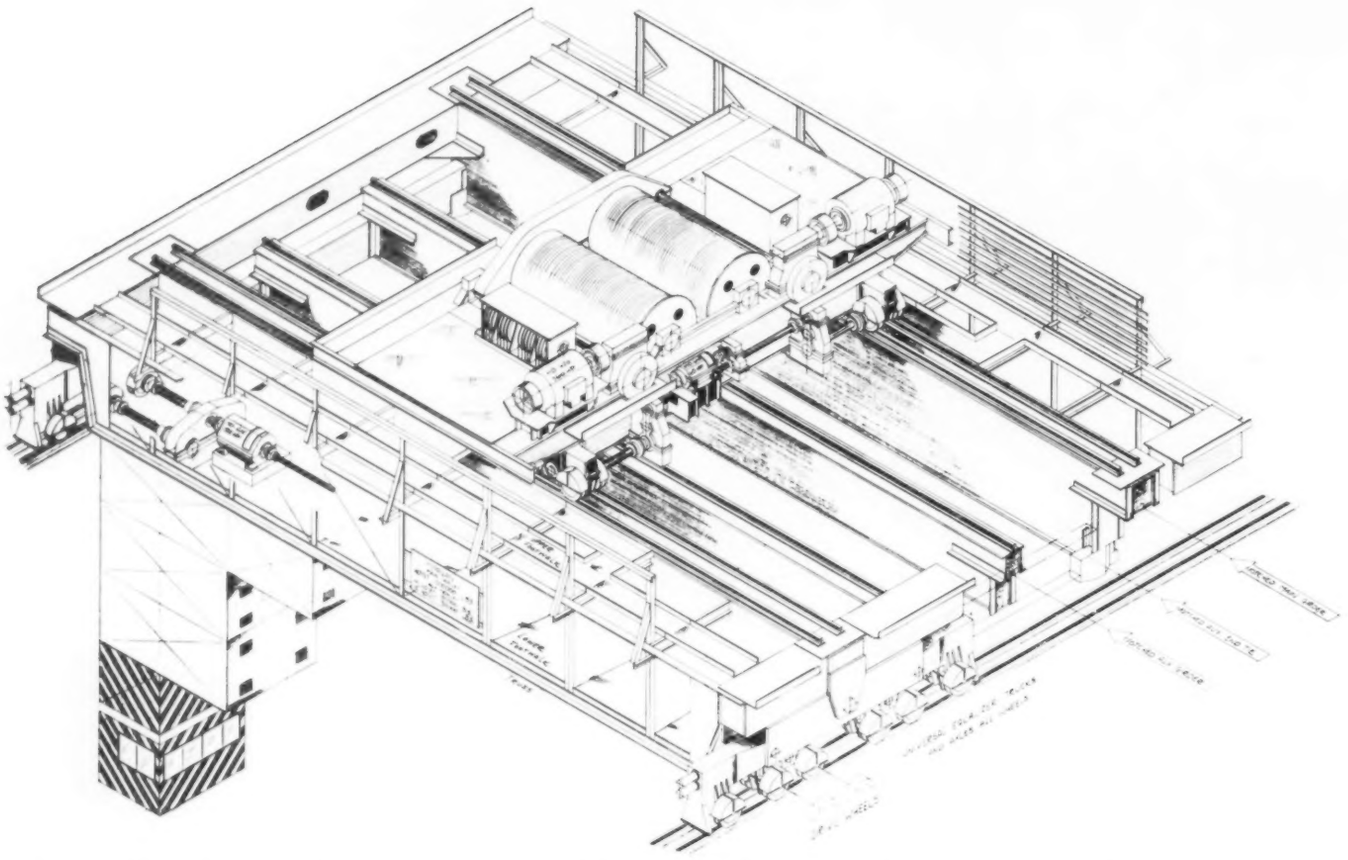


Figure 4 — This isometric plan view of the bridge shows, on the left, one of its four 135-hp drive motors.

maximum load of 127,000-lb. This width was not satisfactory because it would overlap into the areas of the adjacent open hearth furnaces and because crane maintenance would require two additional bays on each end of the open hearth building. Further information from the customer indicated that the crane could not exceed 69 ft-0 in. wide end-to-end of bridge bumpers.

In subsequent layouts the width of the crane (end-to-end of bridge bumpers) was reduced to 68 ft-4 in. by designing the bridge trucks for four wheels instead of the conventional two and by running the wheels on parallel runway rails. Each pair of rails was 36 in. apart, and each rail is carried on a separate building runway girder.

Figure 1 shows an outline section through the open hearth building and an outline of the 500-ton hot metal crane. The crane span is 77 ft-0 in.; the height of building from grade line to top of crane runway rail is 67 ft-10 in. and the distance from the top of the runway rail to the roof truss is 27 ft-0 in. The approaches of the large trolley are 13 ft-10 in. on the cage end and 12 ft-10 in. on the opposite to cage end. The approaches of the small trolley are 6 ft-5⅝ in. on cage end and 5 ft-8⅝ in. on opposite to cage end. The lift of the large trolley is 56 ft-1 in.

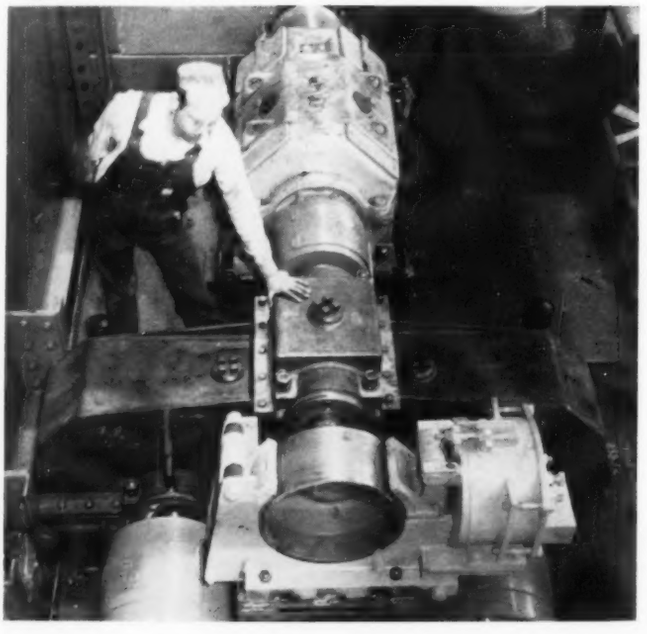
Figure 2 shows the 500-ton ladle crane positioning a large ladle for lining inspection.

Figure 3 shows the ladle crane positioning a large ladle over ingot molds for pouring. The ladle is equipped with two stopper rods so spaced that two ingots can be poured at a time.

Each of the ladles has an outside top diameter of 17 ft-0 in. an outside bottom diameter of 13 ft-10 in., a height of 17 ft-4 in. and holds a maximum capacity of 385 tons of hot metal.

The 500-ton hot metal ladle crane consists of four bridge girders with spans of 77 ft-0 in. center-to-center of end bridge trucks. All motions are driven by 11 mill-type, d-c motors, which total 1660 hp. Each crane has a 75/25-ton auxiliary trolley. The bridge, as mentioned before, and the large or main trolley run on

Figure 5 — This closeup of one of the bridge drive shows its rugged construction.



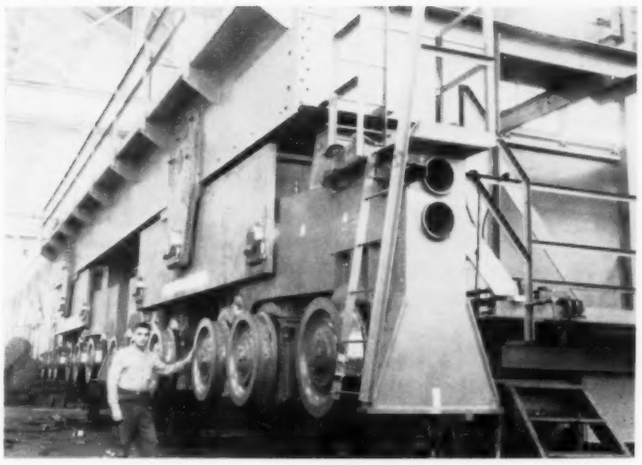


Figure 6 — Shown here is one end of the ladle crane bridge. The bridge has a total of 48 trackwheels.

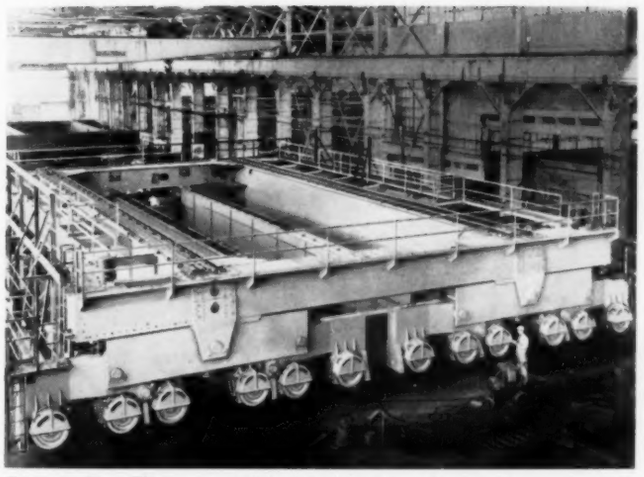


Figure 7 — The assembled bridge is shown here on the shop floor.

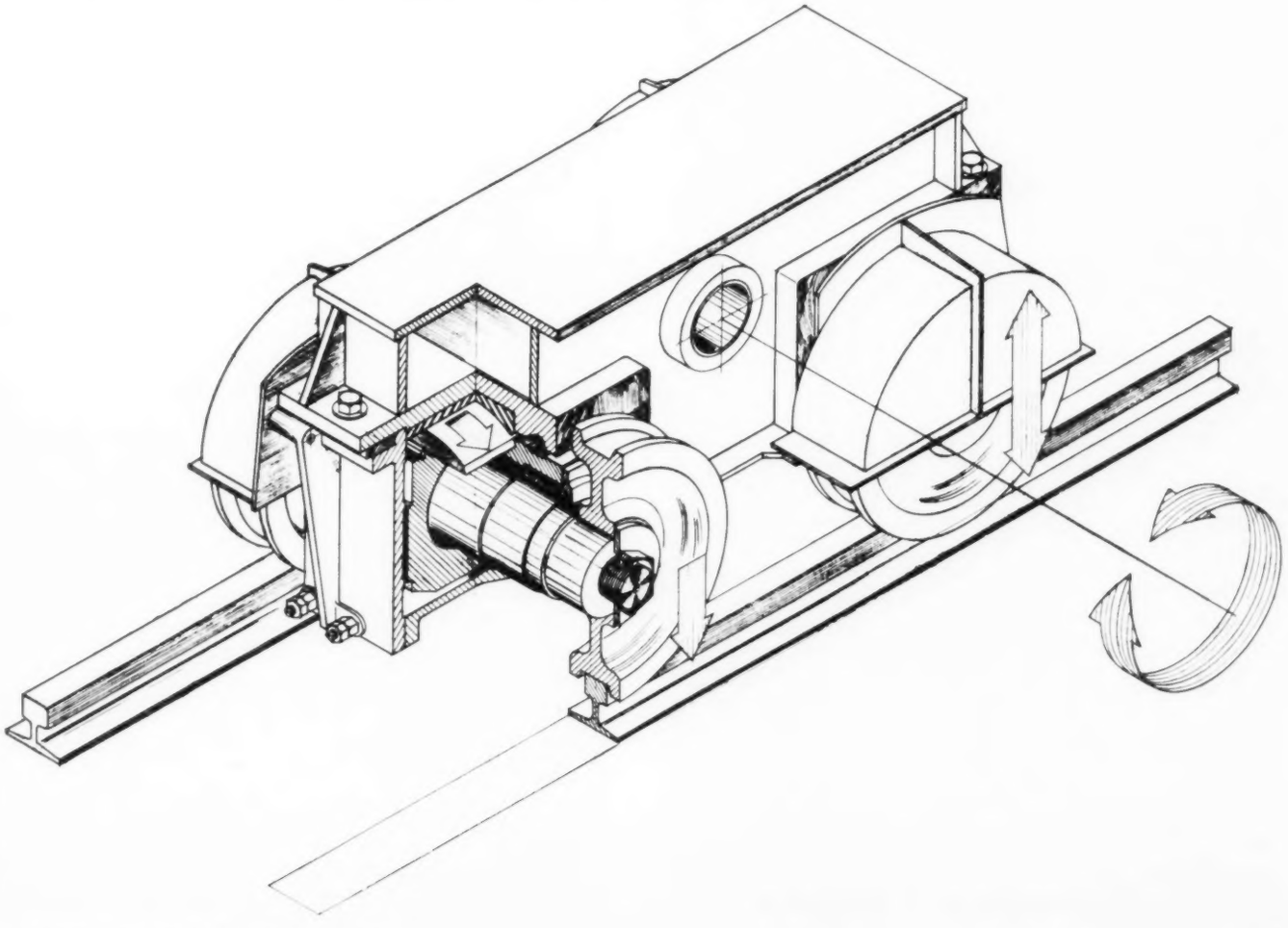
universal-type trucks, each of which has four 30-in. diam wheels. The height of the ladle crane from the top of the runway rail to the maximum height of the trolley is 23 ft, 7½ in., and the height of the bridge from the top of the runway rails to the top of the rails on the main girders is 11 ft 8½ in.

The bridge has a no-load speed of 380 fpm and a full load speed of 315 fpm. The maximum wheel load is 87,500 lb. The bridge is driven by four 135-hp, series wound, mill-type motors, located at the corners of the bridge and wired in parallel. As shown in Figure 4, the two bridge motors on adjacent, parallel corners of the bridge are connected mechanically by a 4½-in. diam lineshaft. The other end of each motor is connected by a flexible coupling to a gear drive which has its two slow speed floating shafts connected to the trackwheel assemblies.

Each drive, as shown in Figure 5, is of rugged construction and has carburized gears. The motor and pinion and mating gear have single helical cut teeth for quiet, smooth operation.

Each bridge, as shown in Figure 6 and 7, has forty-

Figure 8 — Sectional view of bridge truck shows its internal details.



eight 30-in. diam heat treated (carburized) trackwheels with their tread ground to a tolerance of +0.005 in. Two wheels are assembled on each axle, at wheel center-to-center distances of 36 in.

The trucks are of special design, each containing two double-wheel assemblies. Each truck is bored near the top at its center to accommodate an 8-in. diam equalizing pin. Each wheel assembly is self-equalizing as shown in Figure 8. This is mandatory if all wheels are to bear on the building runway rails. Because each rail is supported on a different building girder and each of these girders have different degrees of deflection under load, each wheel assembly must be self-equalizing to insure bearing on the runway rails by all wheels. Figure 9 shows a typical assembled truck in its place on the bridge equalizer, and Figure 10 shows one of the truck drive wheel assemblies.

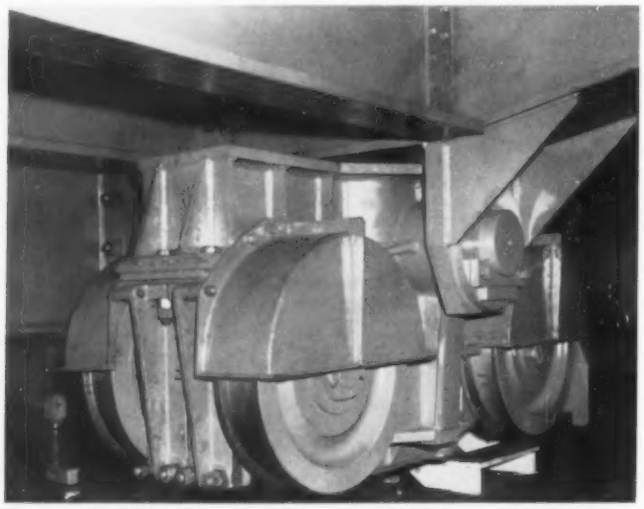


Figure 9 — Typical assembled bridge truck is in its place on the bridge equalizer.

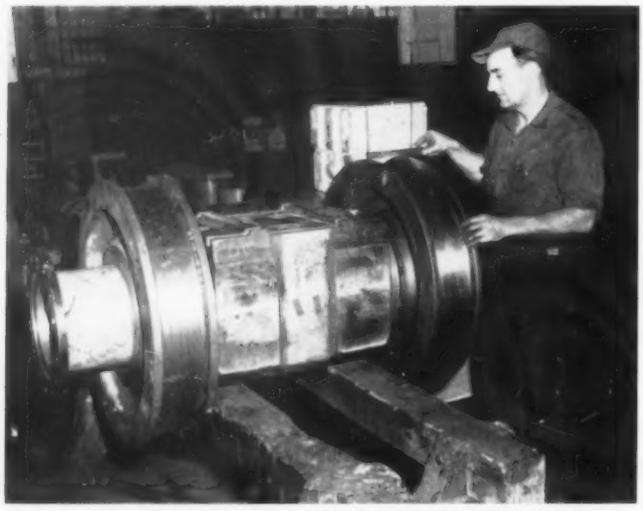


Figure 10 — This closeup of one of the bridge truck drive wheel assemblies shows their large size.

Figure 11 — Extensive walkways are a part of the crane design.

Each truck, completely assembled with wheels, weighs about 20,000 lb. Due to the design of the truck, each wheel assembly can be removed from the truck by jacking the crane up a fraction of an inch, removing the bolted end retainers and rolling the wheel assembly onto a specially constructed dolly.

The bridge has two main walkways located on the outsides of the main girders. A secondary walkway, 2 ft-9 in. wide and located at the same elevation as the top of the main girders, is provided above each of the main walkways for servicing the main trolley collectors and for providing access to the main trolley repair platform. Figure 11 shows a close-up view of one of the secondary walkways. The main trolley collector

Figure 12 — This workman is shown welding one of the bridge's main girders.

Figure 13 — In this view, the cover plate of one of the bridge's main girders is being welded to the web.

bars are on the supporting structure to the left.

The two main bridge girders are tied together at each end of the bridge by their own end ties, and the small trolley auxiliary girder is supported on separate end ties that are fastened to the main girders as shown in Figure 4. The main and auxiliary girders have notched ends as do the auxiliary girder end ties, in order to take the high tensile bolts out of shear, and to provide the most rigid connection possible.

The two main girders each have 40 in. wide by 2¼ in. thick top and bottom universal rolled steel cover plates and two 118½ in. by ¾ in. thick web plate welded together by the automatic submerged arc process. Figures 12 and 13 show one of the main girders being welded.

Figure 14 shows a close-up view of a main girder in place with two parallel 175-lb rails, on 27 in. centers fastened to the top cover. The total weight of each girder, including rails, is 115,000 lb.

The two small girders each have 27 in. wide by 1 in. thick top and bottom universal rolled steel cover plates and two 70 in. by ⅜ in. thick web plates. They are of welded construction. Each girder, with its 175-lb rail, weighs 34,000 lb.

MAIN TROLLEY

The main 500-ton ladle trolley is of all welded construction and has a span of 34 ft-0 in., an overall length of 47 ft-6 in., a width of 30 ft-4 in. and a height of 11 ft-11 in. from the bottom of its wheels to its highest point. It weighs 640,000 lb without ropes, ladle hooks and lifting beam. Figure 15 shows the trolley being assembled in the shop.

The trolley has four universal equalizer trucks each of which has four 30-in. diam wheels. The trolley trucks are constructed the same as the bridge trucks except that their wheels are spaced for running on 27-in. center, parallel rails located on the bridge girders. Maximum wheel load is 110,000 lb.

The trolley is driven through two A-5 type drives by two 65-hp, series wound, mill-type motors which are wired in series through two A-5 type drives. Its no load speed is 75 fpm and its full load speed is 50 fpm. Eight of the sixteen wheels are driven.

The hoist consists of two 87 in. pitch diam by 15 ft-6¾ in. long, welded, geared together, steel rope drums. Each drum is supported on two self-alining bearings and weighs 50,000 lb. Figure 16 shows one of the drums being machined.

Hoist speed is 10 fpm, and the maximum lift of ladle hooks before engaging limit switches is 56 ft-1 in.

There are seventy-six parts of 1⅜ in. diam hemp center steel wire rope with rope equalizers located on the lifting beam.

The trolley is of interlocked drum design. Each drum is driven by one 360-hp motor and each gear train has a ratchet. The ratchets prevent gear train stresses that would otherwise occur (1) when the hoist brake sets on one hoisting motor before the other, or (2) when one motor becomes energized ahead of the other.

Each hoist gear train is composed of one 360-hp motor, two magnetic brakes and a 31¼ in. center straight worm gear set whose worm gear shaft has a ratchet for driving the drum pinion meshed with the drum gear. This drum gear, being interlocked, insures uniform hoisting speed at all times. Each worm gear set is spray lubricated on the top if its worm in addition to its worm gear dipping in an oil bath.

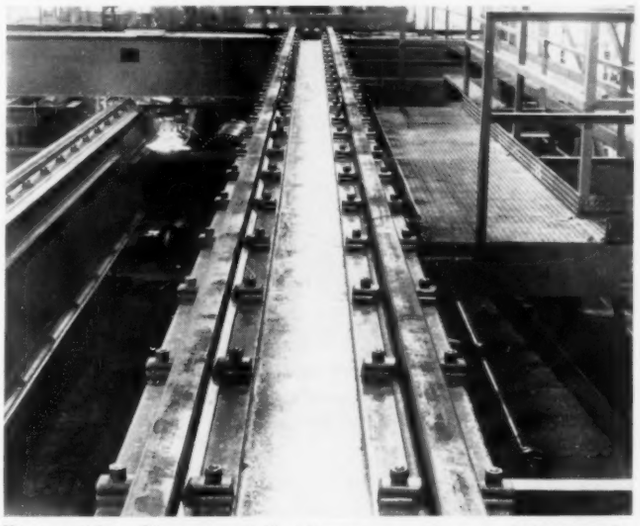


Figure 14 — Closeup of the top cover of one of the main bridge girders. Note the pair of trolley rails on the cover.

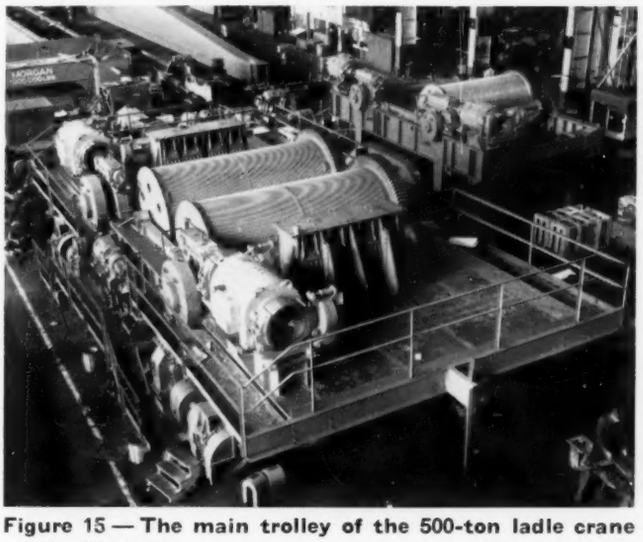


Figure 15 — The main trolley of the 500-ton ladle crane weighs 320 tons.

Figure 16 — This steel rope drum is one of the two required by the main hoist.

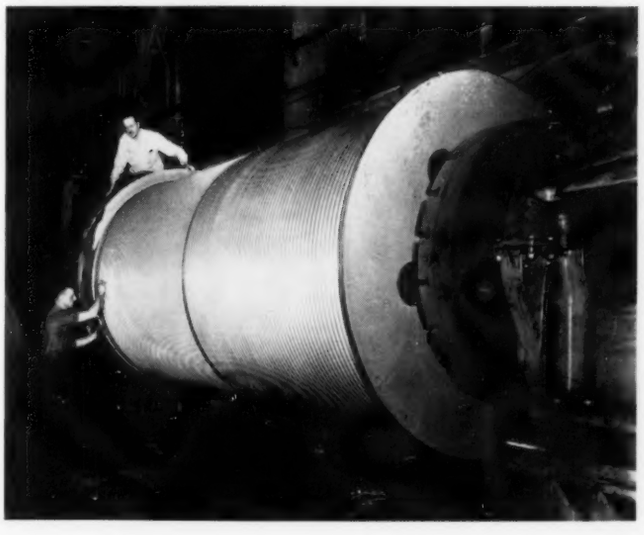


Figure 17 — The main trolley frame is shown being assembled on the manufacturer's shop floor.

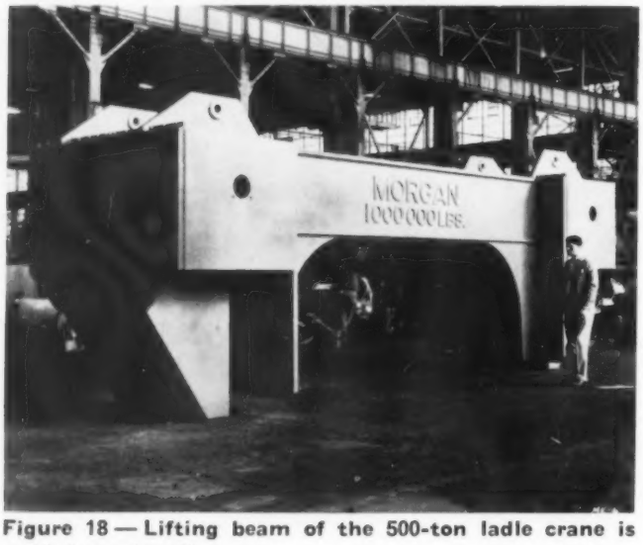


Figure 18 — Lifting beam of the 500-ton ladle crane is welded construction.

Figure 19 — Shown here is one of the two 68,000-lb laminated steel hooks used by the main hoist.

The trolley frame, due to its large size, could not be shipped as an integral unit like other ladle crane trolley frames of smaller capacities. It had to be designed and built so that it could be dismantled for shipping and field reassembled in its place on the bridge. Welding and high tensile bolts were used for reassembly. An integral welded frame resulted. Figure 18 shows the trolley frame being assembled in the shop. The two side frames are tied together mainly by two end ties. The side frames have machined surfaces for receiving the end ties whose ends are machined and whose flanges are beveled for field welding. The trolley frame, without mechanical and electrical components, weighs 138,000 lb.

Each side frame has top and bottom cover plates 28 in. wide by 2 in. thick and web plates 53½ in. by ¾ in. thick.

The lifting beam, shown in Figure 18, for the two large ladle hooks is 9 ft-9 in. high by 27 ft-4 in. long by 7 ft-5 in. wide and weighs 54,000 lb. The beam is of all-welded steel construction. The two ladle hooks, when assembled with the beam, are on 19 ft-0 in. centers.

Each ladle hook is 17 ft-5 in. long by 7 ft-3 in. wide by 12½ in. thick. The hooks are of laminated construction comprised of four ⅞ in. thick and nine 1 in. thick laminated plates held together by a series of 1¼ in. diam rivets and by welding on the outside edges in accordance with accepted standards. Two hooks have a combined weight of 68,000 lb. Figure 19 shows a hook in a raised position that shows its relative size compared with the girl sitting in its throat.

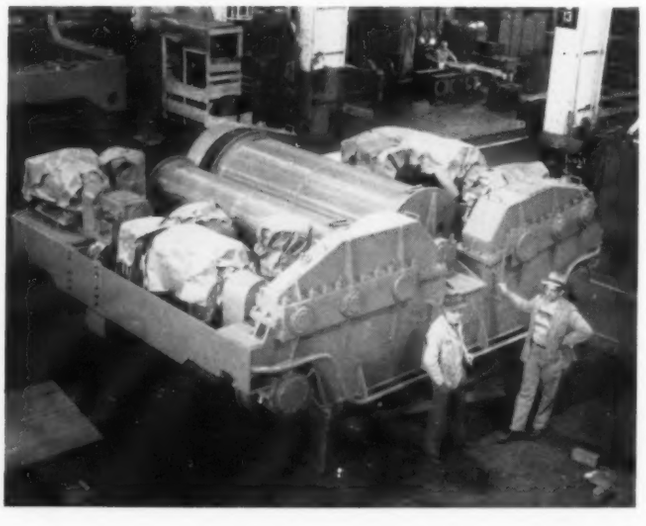
SMALL TROLLEY

The small or auxiliary trolley is of a compact design and has one 75-ton hoist and one 25-ton hoist. It has a span of 12 ft-3 in., a wheel base of 14 ft-3 in., an overall length of 17 ft-11 in., a width of 14 ft-10 ½ in. and weighs 110,000 lb.

The trolley is driven through two of its four 24 in. diam wheels by a 33-hp, mill-type, series wound motor at a full load speed of 133 fpm.

The main hoist, 75-ton capacity, has a 48 in. pitch

Figure 20 — The small trolley, shown here, is ready for shipment to the customer.



diam by 9 ft-7 in. long, body welded, steel drum powered by a 135-hp, series-wound d-c motor through a triple spur gear reduction. There are 12 parts of 1⅛ in. diam steel wire rope. Hook travel speed is 22 fpm with a full load. The total lift is 75 ft-0 in.

The 25-ton hoist has a 26¼ in. diam by 9 ft-11½ in. long, welded steel drum connected to a 100-hp, series-wound d-c motor through a double reduction spur gear drive. There are eight parts of ⅞ in. diam steel wire rope. The hook travels at a full load speed of 46 fpm. The total lift is 78 ft-0 in. Figure 20 shows the small trolley, in the shop, completely assembled and ready for shipment. The rub rails on the sides of the trolley are for protection of the main hoist ropes.

CAGE

The cage—which is attached to the bridge and which houses the electrical control, auto-pour equipment and crane operator—is 46 ft-8-in. deep from the top of the runway rail and contains five decks as shown in Figure 2. Outside stairs and walkways are provided on the cage. They run from the operator's compartment on the first deck to each succeeding deck and end at the walkway on the bridge. A removable side is provided on each of the four upper decks for installing and replacing electrical equipment. The complete cage contains approximately 31,300 cu ft.

SUMMARY

The crane is of welded steel construction throughout with automatic submerged arc welding where practicable. Welded gear housings, trucks, trolley frames, hook, lifting beam, etc., were stress relieved in our new 20 ft by 15 ft by 52 ft car bottom, stress relieving furnace and cleaned with shotblast equipment.

Each crane is reeved with 6660 ft of 1⅜ in. diam steel wire rope, 1200 ft of 1⅛ in. diam rope and 765 ft of ⅞-in. diam rope, a total of 8625 linear ft or 1⅔ miles of steel wire rope.

Approximately 10,000 engineering-man-hours were required to design and make detail drawings. Twenty-five railroad cars were required to ship each crane. ▲

Tube Mill Practice

A selection of articles from the IRON AND STEEL ENGINEER on various phases of tubemaking.

(Published in 1953)

Practical information on layout and operation of facilities for seamless, butt and electric weld pipe, a field in which little information has been published...23 articles by 20 authoritative writers ...invaluable for engineers, operators, trainees and students.

8¼ x 11¼ in.....196 pages, illustrated, clothbound

Price: To AISE Members...$2.00

To Others.....$4.00

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building

Pittsburgh 22, Pa.

AISE STANDARD NO. 8

Crane And Mill Auxiliary Drive Motor Cable Size Wiring Standards

Adopted October 2, 1949

Revised September 22, 1958

Foreword

The following standard represents a great deal of exhaustive and careful work on the part of the AISE Wiring Committee under the chairmanship of J. E. Bodoh and C. G. Dimitt of the United States Steel Corp.

The work was originally limited to crane motor applications, but since the same motors are used on mill auxiliary drives, this standard can be applied to all types of mill motor applications if the appropriate service is selected.

This standard was published in 1949 as a Tentative Standard in order that comments and criticisms might be obtained from the AISE membership or other users. Changes resulting from these comments have been incorporated in the final standard.

Due to confusion in identifying mill motor ratings by frame sizes and by horsepower ratings, tables in the revised standard cover cable sizes based on frame sizes and on group horsepower ranges. The tables have been uniformly arranged to simplify the selection of desired motor ratings or cable size data. A tabulation and description of the cable size tables appear under Section III and Section IV.

The complete detail data and research work on which this standard is based appeared in a report by C. G. Dimitt entitled "Report of AISE Crane Wiring Standardization Committee" in the July, 1950, issue of the Iron and Steel Engineer. Additional data were presented in a "Progress Report" which appeared in the May, 1951, issue of the Iron and Steel Engineer.

AISE STANDARD NO. 8

I. SCOPE

A. The purpose of AISE Standard No. 8 is to establish definite minimum conductor sizes which equipment suppliers and users shall specify for wiring mill type motors for crane and auxiliary mill drives.

B. For wiring applications, cranes have been classified for average duty and heavy duty; for indoor and outdoor applications, subject to average temperature, high temperature and corrosive conditions. However, mill auxiliary drives have not yet been classified in like manner.

II. CRANE CLASSIFICATION

A. To simplify the classification of cranes, Table I lists the majority of crane applications encountered in steel plants. This table is based on Table 43-III included in the AISE Specifications for Electric Overhead Traveling Cranes for Steel Mill Service, AISE Standard No. 6. The tabulation of types of cranes follows Table 43-III very closely.

B. Types of crane service are shown in Table I. These selections are based on experience, on the "average number of hours operation in one year," the "per cent time on in operational hour," and the "number of moves per hour." Referring to Table 43-III, a crane operated over 4300 hours a year (50 per cent of the over-all average hours), having a motion with 40 per cent or more time on in operational hours, or having more than 35 moves per hr, may generally be classified as subject to heavy duty service. A crane operated less than 4300 hr a year, having all motions requiring less than 40 per cent time on in operational hours, and having less than 35 moves per hr, may be generally considered as subject to average duty service. If the maximum crane temperature during operation is over 55 C

Table I

Classification of Crane Service

Type of crane	Service							
	I	II	A—Average duty			B—Heavy duty		
	Indoor	Outdoor	1 Avg temp	2 High temp	3 Corrosion resistant	1 Avg temp	2 High temp	3 Corrosion resistant
1. Coke plant and blast furnace cranes								
Drawing machine (coke pusher)		X					X	
Bucket handling		X				X		
Stock yard		X					X	
Slag handling		X					X	X
Scrap yard		X					X	
Cast house	X		X		X			
Pig machine	X			X				
Ladle house	X		X					
Skull cracker		X				X		
Sand house (bucket)	X		X					
Settling basin		X	X		X			
Car repair shop	X		X					
Ore bridge		X					X	
Coke ovens (coal bridge)		X					X	
2. Open hearth, electric furnace, Bessemer cranes								
Charging machines	X						X	
Hot metal crane (charging)	X						X	
Ladle	X						X	
Metal mixer	X						X	
Electric furnace charging	X						X	
Stock yard		X				X		
Scrap preparation		X				X		
Scrap baler	X					X		
Scrap shear	X					X		
Hot top	X					X		
Bucket		X					X	
Slag handling		X					X	
Cinder yard		X					X	
Skull cracker		X				X		
General service	X	X	X					
3. Ingot handling cranes								
Ingot handling		X				X		
Soaking pit	X						X	
Stripper	X						X	
Mold yard		X					X	
4. Rolling mill cranes								
Slab yard	X					X		
Slab furnace charging	X						X	
Slab chargers overhead	X						X	
Plate and strip handling	X						X	
Billet mill	X		X			X		
Billet shipping	X					X		
Rail mill	X		X			X		
Rail loading dock	X	X	X			X		
Rail shipping	X	X				X	X	
Hot mill	X					X	X	
Cold strip mill	X					X		
Coil storage	X					X		

Type of crane	Service							
	I	II	A—Average duty			B—Heavy duty		
	Indoor	Outdoor	1 Avg temp	2 High temp	3 Corrosion resistant	1 Avg temp	2 High temp	3 Corrosion resistant
Roll shop	X		X					
Mill service	X					X		
Machine shop	X		X					
Cooling building	X					X		
Inspection and conditioning	X		X					
Pit cover	X					X		
5. Finishing mill cranes								
Slab storage	X	X				X		
Charging machines	X					X		
Billet yard	X	X				X		
Furnace room	X						X	
Mill service	X					X		
Shipping	X					X		
Warehouse	X					X		
Stock	X		X					
Sorting room	X		X					
Shear	X					X		
Scale pits	X		X					
Hot bed	X			X			X	
Pickling	X					X		X
Quenching	X			X				
Tin mill	X						X	
Annealing	X						X	
Battery shop	X		X		X			
Scarfing	X					X		
6. Rod and wire mill cranes								
Billet yard	X					X		
Furnace skid charging	X		X					
Rod mill	X		X					
Rod dock		X				X		
Cleaning house	X					X		
Pot annealing	X					X		
Rod storage	X					X		
Patenting department	X		X					
Bar bending and storage	X					X		
Shipping	X					X		
7. Tube mill cranes								
Hot mill	X						X	
Finishing mill	X					X		
Galvanizing	X					X		X
8. Miscellaneous cranes								
Forging manipulators	X						X	
Hydraulic forging	X						X	
Warehouse	X	X	X					
Gantry		X				X		
Repair	X		X					
Machine shop	X		X			X		
Service	X		X					
Weld shop	X		X					
Power house	X		X					
Coal lorry (boiler house)	X	X	X					
Motor room	X		X					

TABLE II

Cable and Conduit Sizes (AISE Standard D-C Mill Motors—Frames MD, MC and SW—Totally Enclosed)

Motor frame data					Totally enclosed motor ratings						Cable required for one leg and conduit required for four legs (reversing series motor)									
					1 hr		½ hr		Continuous force ventilated		Average intermittent duty service (1 hr)			Heavy intermittent duty service (½ hr)			Continuous duty force-ventilated service			
AISE 1949	AISE 1940	General Electric	Westing-house	Crocker-Wheeler	Hp	Amp	Hp	Amp	Hp	Amp	Cable size, per leg	No.	Conduit Size, in.	Cable size, per leg	No.	Conduit Size, in.	Cable size, per leg	No.	Conduit Size, in.
2	2	MD-402	MC-21	SW-5	5	21	6½	29	5	21	8	1	1¼	8	1	1¼	8	1	1¼
602	3	MD-403	MC-31	SW-7½	7½	31	10	44	7½	31	8	1	1¼	8	1	1¼	8	1	1¼
603	4	MD-404	MC-41	SW-10	10	40	13½	57	10	40	8	1	1¼	8	1	1¼	6	1	1¼
604	6	MD-406	MC-61	SW-15	15	57	19	77	15	57	8	1	1¼	6	1	1¼	4	1	1½
606	8	MD-408	MC-81	SW-25	25	95	33	126	25	95	4	1	1½	2	1	2	1	1	2
608	10	MD-410	MC-101	SW-35	35	132	45	175	35	132	2	1	2	1	1	2	2/0	1	2½
610	12	MD-412	MC-121	SW-50	50	185	65	245	50	185	1/0	1	2	2/0	1	2½	4/0	1	3
612	14	MD-414	MC-141	SW-75	75	272	100	368	75	272	3/0	1	2½	4/0	1	3	400	1	4
614	16	MD-416	MC-161	SW-100	100	360	135	500	100	360	250	1	3	300	1	3	2-4/0	2	3
616	18	MD-418	MC-181	SW-150	150	540	200	740	150	540	400	1	4	400	1	4	2-400	2	4
														2-250	2	3			
618		MD-420	...	...	200	730	265	960	200	730	2-250	2	3	2-300	2	3	3-350	4	3
620					275	975	360	1314	275	975	2-350	2	4	2-400	2	4	4-350	4	4
622					375	1370	500	1830	375	1370	2-500	4	3	3-400	4	3	6-300	4	4
624					500	1830	660	2400	500	1830	3-500	4	4	4-350	4	4	6-500	8	3

(131 F), the service may be classified as high temperature. If the maximum crane temperature is under 55 C (131 F), the service may be classified as average temperature. Classification of indoor, outdoor and corrosion resistant are included to cover distinctions in equipment or protective features which may be necessary for cranes in such service.

C. Due to the differences in plant layouts, a given kind of crane may be indoor and outdoor, average and high temperature, or average and heavy duty. A service classification may be fully covered by a symbol (keyed to Table I column headings) such as IB2, for open hearth charging machines, meaning that the classification is indoor, heavy duty and subject to high temperatures.

III. TYPES OF D-C MILL MOTORS

Standard cable and conduit sizes have been developed for the following types of mill motors:

1. AISE Standard No. 1 (1949 Revised 1957), frame sizes 602 to 624.
2. AISE D-C Mill Motor Standard (1940) frame sizes 2 to 18.
3. Crocker-Wheeler Type W frame sizes AW to IW.
4. Westinghouse Type MC frame sizes 20 to 165.
5. General Electric Type MD frame sizes 101 to 109.

IV. CABLE SIZE AND MOTOR DATA TABLES

TABLE II—"Cable and Conduit Sizes, AISE Standard D-C Mill Motors—Frames MD, MC and SW, Totally Enclosed for average intermittent duty service (1 hr), for heavy intermittent duty service (½ hr), and for continuous duty force-ventilated service.

TABLE III—"Cable and Conduit Sizes, AISE Standard D-C Mill Motors, 600 Series Frames—Protected Self-Ventilated and Force-Ventilated," for 1-hr duty protected self-ventilated service, for continuous duty protected self-ventilated service, and for continuous duty protected, force-ventilated service.

TABLE IV—"Cable and Conduit Sizes, Miscellaneous D-C Mill Motors, by Frame Sizes, Totally Enclosed," for average duty intermittent service (1 hr), for heavy duty intermittent service (½ hr), and for continuous duty force-ventilated service.

TABLE V—"Cable and Conduit Sizes, Miscellaneous D-C Mill Type Motors, Totally Enclosed," grouped in horsepower ranges, for average duty intermittent service (1 hr), for heavy duty intermittent service (½ hr), and for continuous duty force-ventilated service.

TABLE VI—"Cable and Conduit Data—Intermittent and Continuous Cable Capacity Ratings, Dimensions, etc., for RH and AVA Cable." Also included are manufacturers cable size data and cable-con-

TABLE III

Cable and Conduit Sizes (AISE Standard D-C Mill Motors—600 Series Frames—Protected Self-Ventilated and Force-Ventilated)

Motor frame AISE 1957	Protected motor ratings						Cable required for one leg and conduit required for four legs (reversing series motor)								
	Self-ventilated				Force-ventilated		One-hour duty protected self-ventilated service			Continuous duty protected self-ventilated service			Continuous duty protected force-ventilated service		
	1 hr		Continuous		Continuous			Conduit			Conduit			Conduit	
	Hp	Amp	Hp	Amp	Hp	Amp	Cable size per leg	No.	Size, in.	Cable size per leg	No.	Size, in.	Cable size per leg	No.	Size, in.
602	9¼	34	7½	31	9¼	34	8	1	1¼	8	1	1¼	8	1	1¼
603	12½	46	10	40	12½	46	8	1	1¼	6	1	1¼	6	1	1¼
604	19	77	15	57	19	77	6	1	1¼	4	1	1½	2	1	1½
606	31½	117	25	95	31½	117	2	1	2	1	1	2	1/0	1	2
608	44	168	35	132	44	168	1/0	1	2	2/0	1	2½	3/0	1	2½
610	62½	232	50	185	62½	232	3/0	1	2½	4/0	1	3	300	1	3
612	94	348	75	272	94	348	250	1	3	400	1	4	2-4/0	2	3
614	125	463	100	360	125	463	350	1	4	2-4/0	2	3	2-300	2	3
616	187½	692	150	540	187½	692	2-250	2	3	2-400	2	4	3-3000	4	3
618	250	925	200	730	250	925	2-350	2	4	3-350	4	3	3-500	4	3
620	350	1290	275	975	350	1290	2-500	4 2	3 4	4-350	4	4	6-300	8	3
622	475	1760	375	1370	475	1760	3-500	4	3	6-300	4	4	6-500	8	3
624	625	2220	500	1830	625	2220	4-500	8 4	3 4	6-500	8	3	8-500	8	4

TABLE IV

Cable and Conduit Sizes (Miscellaneous D-C Mill Motors by Frame Sizes—Totally Enclosed)

Motor frame data		Totally enclosed motor ratings						Cable required for one leg and conduit required for four legs (reversing series motor)								
		1 hr		½ hr		Continuous force-ventilated		Average duty intermittent service (1 hr)			Heavy duty intermittent service (½ hr)			Continuous duty force-ventilated service		
									Conduit			Conduit			Conduit	
Frame size	Manufacturer	Hp	Amp	Hp	Amp	Hp	Amp	Cable size per leg	No.	Size, in.	Cable size per leg	No.	Size, in.	Cable size per leg	No.	Size, in.
MD101	G-E	4	17	5	23	4	17	8	1	1¼	8	1	1¼	8	1	1¼
MC20	West	6	25	7½	34	6	25	8	1	1¼	8	1	1¼	8	1	1¼
AW	C-W	8	37	10	50	8	37	8	1	1¼	8	1	1¼	8	1	1¼
MD102	G-E	9	33	12	50	9	33	8	1	1¼	8	1	1¼	8	1	1¼
MC30	West	12	47	15	62	12	47	8	1	1¼	6	1	1¼	6	1	1¼
MD103	G-E	13	50	17	70	13	50	8	1	1¼	6	1	1¼	6	1	1¼
BW	C-W	16	56	20	86	16	56	8	1	1¼	6	1	1¼	6	1	1¼
MC40	West	20	76	28	116	20	76	6	1	1¼	4	1	1½	4	1	1½
MD104	G-E	20	77	30	124	20	77	6	1	1¼	2	1	2	4	1	1½
C-W	C-W	25	88	30	112	25	88	4	1	1¼	4	1	1½	2	1	2
MD104½	G-E	30	112	45	175	30	112	2	1	2	1	1	2	2	1	2
MC50	West	30	114	40	157	30	114	2	1	2	2	1	2	2	1	2
DW	C-W	36	138	45	180	36	138	2	1	2	1	1	2	1/0	1	2
MD105	G-E	40	154	50	200	40	154	1/0	1	2	1/0	1	2	1/0	1	2
EW	C-W	47	175	60	245	47	175	1/0	1	2	2/0	1	2½	2/0	1	2½
MC60	West	50	172	65	250	50	172	1/0	1	2	2/0	1	2½	2/0	1	2½
FW	C-W	66	240	85	320	66	240	3/0	1	2½	3/0	1	2½	250	1	3
MC70	West	70	255	90	346	70	255	3/0	1	2½	4/0	1	3	250	1	3
MD106	G-E	70	264	85	324	70	264	3/0	1	2½	4/0	1	3	300	1	3
MD107	G-E	85	316	110	432	85	316	4/0	1	3	250	1	3	350 2-2/0	1 2	4 3
MC80	West	85	320	110	410	85	320	4/0	1	3	250	1	3	350 2-2/0	1 2	4 3
GW	C-W	90	310	110	400	90	310	4/0	1	3	250	1	3	350 2-2/0	1 2	4 3
MC90	West	100	360	140	520	100	360	250	1	3	300	1	3	500	1 2	4 3
MD108	G-E	100	365	140	565	100	365	250	1	3	300	1	3	500	1 2	4 3
HW	C-W	120	440	160	590	120	440	300	1	3	350	1 2	4 3	2-4/0	2	3
MC100	West	150	540	200	730	150	540	400 2-3/0	1 2	4 3	500 2-250	1 2	4 3	2-300	2	3
IW	C-W	175	620	225	800	175	620	500	1 2	4 3	2-250	2	3	2-350	2 4	4 3
MD109	G-E	175	640	225	840	175	640	500	1 2	4 3	2-250	2	3	2-350	2 4	4 3
MC103	West	180	660	250	900	180	660	2-250	2	3	2-300	2	3	2-400	2 4	4 3
MD109½	G-E	255	920	325	1160	255	920	2-350	2 4	4 3	2-400	2 4	4 3	3-400	4	3
MC165	West	275	970	325	1160	275	970	2-350	2 4	4 3	2-400	2 4	4 3	3-400	4	3
MD110	G-E	295	1060	385	1380	295	1060	2-400	2 4	4 3	2-500	2 4	4 3	3-500	4	3

duit data taken from the National Electric Code for ready reference.

TABLE VII—"Cable Sizes—Resistor to Controller Wiring."

V. CABLE SIZES AND CAPACITY RATING DATA

The tables give cable sizes for the motor ratings tabulated. Cable sizes for average intermittent duty have been selected so that they can carry one-hour motor rated current for 60 min without raising the total temperature of RH cable over 75 C and AVA cable over 110 C. Cable sizes for heavy intermittent duty have been selected so that they can carry 30-minute motor rated current for 30 minutes without raising the total temperature of RH cable over 75 C, and AVA cable over 110 C. Cable sizes for force-ventilated continuous duty, and for protected self-ventilated continuous duty have been selected so that they can carry the 1-hr rating of the motor continuously without raising the total temperature of RH cable over 75 C and AVA cable

TABLE V

Cable and Conduit Sizes (Miscellaneous D-C Mill Type Motors by Horsepower Ranges—Totally Enclosed)

Totally enclosed motor ratings						Cable required for one leg and conduit required for four legs (reversing series motor)								
						Average duty intermittent service (1 hr)			Heavy duty intermittent service (½ hr)			Continuous duty force-ventilated service		
1 hr		½ hr		Continuous force-ventilated		Cable size per leg	Conduit		Cable size per leg	Conduit		Cable size per leg	Conduit	
Hp	Amp	Hp	Amp	Hp	Amp		No.	Size, in.		No.	Size, in.		No.	Size, in.
4–10	17–40	5–13½	23–57	4–10	17–40	8	1	1¼	8	1	1¼	8	1	1¼
12–16	47–57	15–20	62–86	12–16	47–57	8	1	1¼	6	1	1¼	6	1	1¼
20–30	76–114	28–40	116–157	20–30	76–114	4	1	1½	2	1	2	2	1	2
30–36	112–138	45	175–180	30–35	112–138	2	1	2	1	1	2	1	1	2
40	154	50	200	40	154	1	1	2	1/0	1	2	2/0	1	2½
47–50	175–185	60–65	245–250	47–50	175–185	1/0	1	2	2/0	1	2½	3/0	1	2½
66–75	240–272	85–100	320–368	66–75	240–272	3/0	1	2½	4/0	1	3	300	1	3
85–90	310–320	110	400–432	85–90	310–320	4/0	1	3	250	1	3	350 2-2/0	2 1	3 4
100	360–365	135–140	500–565	100	365	250	1	3	300	1	3	500 2-4/0	2 1	3 4
120	440	160	500	120	440	300	1	3	350	2 1	3 4	2-4/0	2	3
150–175	540–640	200–225	730–840	150–175	540–640	500	2 1	3 4	2-250	2	3	2-350	4 2	3 4
180–200	660–730	250–265	900–960	180–200	660–730	2-250	2	3	2-300	2	3	2-500	4 2	3 4
255	920	300	1100	255	920	2-350	4 2	3 4	2-400	4 2	3 4	3-400	4	3
275	970	325	1160	275	970	2-350	4 2	3 4	2-400	4 2	3 4	3-400	4	3
295	1060	385	1380	295	1060	2-400	4 2	3 4	2-500	4 2	3 4	3-500	4	3
375	1370	500	1830	375	1370	2-500	4 2	3 4	3-400	4	3	4-400 4-500	4	4
500	1830	660	2400	500	1830	3-500	4	3	4-350	4	4	6-350	4	4

TABLE VI

Cable and Conduit Data (Intermittent and Continuous Cable Capacity Ratings, Dimensions, etc., for RH and AVA Cables)

Cable size	Ampere RH-75 C rise**			Ampere AVA-110 C rise**			Nominal outer* diam of cable, in.		No. of* strands	No. of cables in one conduit RH-75 C and AVA-110 C rise							
	Ratings			Ratings													
AWG or MCM	30 min	60 min	Continuous	30 min	60 min	Continuous	RH 600 volt	AVA 600 volt	RH and AVA	1	2	3	4	5	6	7	8
8	60	55	45	80	73	60	0.350	0.350	7	½	¾	¾	1	1¼	1¼	1¼	1½
6	86	76	65	105	93	80	0.390	0.400	7	½	1	1	1¼	1½	1½	2	2
4	117	100	85	147	126	107	0.440	0.450	7	½	1¼	1¼	1½	1½	2	2	2
2	160	137	115	190	163	137	0.500	0.510	7	¾	1¼	1¼	2	2	2	2½	2½
1	175	143	130	215	177	161	0.560	0.580	19	¾	1½	1½	2	2½	2½	2½	3
1/0	233	190	150	294	239	190	0.600	0.620	19	1	1½	2	2	2½	2½	3	3
2/0	267	222	175	331	275	217	0.640	0.670	19	1	2	2	2½	2½	3	3	3
3/0	341	280	200	413	339	243	0.700	0.720	19	1	2	2	2½	3	3	3	4
4/0	369	295	230	440	352	275	0.760	0.780	19	1¼	2	2½	3	3	3	4	4
250	420	364	255	516	447	315	0.840	0.880	37	1¼	2½	2½	3	3	4	4	4
300	582	455	285	707	554	347	0.910	0.930	37	1¼	2½	2½	3	4	4	4	
350	646	486	310	809	616	392	0.960	0.980	37	1¼	3	3	4	4	4		
400	688	538	335	856	666	418	1.010	1.030	37	1½	3	3	4	4	4		
500	847	660	380	1004	815	468	1.090	1.110	37	1½	3	3	4	4			

From 1956 national electric code

* Typical data taken from cable manufacturers published catalog data for conduit installations.
** Based on four conductors per conduit.

over 110 C. For crane motors having intermittent duty, cables are to be selected on an average duty or heavy duty basis as determined by the data given in Section II. Cable sizes for continuous duty service apply to both self-ventilated and force-ventilated frames as indicated in the tables.

The current capacity ratings which have been established for the conductor sizes selected in RH (rubber) and AVA insulations are given in Table VI. These ratings are based on the research work outlined in the Foreword.

VI. MINIMUM SIZE CABLES

A. A minimum size conductor, No. 8 cable, has been determined, based on mechanical strength and resistance to rough service conditions.

B. For compound or shunt-wound motor shunt field circuits, the minimum size conductor, No. 8 cable, shall be installed in separate conduit for each circuit. The minimum size conduit shall be 1 in.

VII. CONDUCTOR INSULATION

A. For cranes and mill auxiliary drives, if the maximum motor ambient temperature during operation is under 55 C (131 F), RH cable with moisture-resistant 75 C insulation with neoprene covering and standard stranding will be used. For cranes, these normally are the items which are listed in the average temperature and corrosion resistant columns of Table I. If the maximum motor ambient temperature during operation is over 55 C (131 F), AVA cable having asbestos varnished cambric asbestos 110 C insulation with moisture impregnation and standard stranding will be used. For cranes, these are the items listed under the high temperature columns of Table I.

B. Unless otherwise specified, cable shall be for 600-volt service. In some cases 1000-volt cable may be justified.

C. Where operating conditions justify, special insulations may be specified such as silicone, asbestos-copper, polyester, etc.

D. When necessary for easier pulling of cable through conduit, the next more flexible stranding will be used.

TABLE VII
Cable Sizes (Resistor to Controller Wiring)

AISE frame	Resistor Cable AVA 110 C		
	Average duty intermittent service (1-hr)	Heavy duty intermittent service (½-hr)	Continuous duty force-ventilated service
2	No. 8 AWG	No. 8 AWG	No. 8 AWG
602	No. 8 AWG	No. 8 AWG	No. 8 AWG
603	No. 8 AWG	No. 8 AWG	No. 8 AWG
604	No. 8 AWG	No. 8 AWG	No. 8 AWG
606	No. 6 AWG	No. 4 AWG	No. 4 AWG
608	No. 4 AWG	No. 2 AWG	No. 2 AWG
610	No. 1 AWG	No. 1/0 AWG	No. 1/0 AWG
612	No. 2/0 AWG	No. 3/0 AWG	No. 4/0 AWG
614	No. 4/0 AWG	250 MCM	350 MCM
616	300 MCM	350 MCM	2-4/0
618	2-4/0	2-250 MCM	3-350 MCM
620	3-3/0	2-300 MCM	3-350 MCM
622	2-400 MCM	3-300 MCM	3-500 MCM
624	3-350 MCM	3-350 MCM	5-350 MCM

AISE Helps INSTEP

The Cleveland District Section meeting held on Tuesday, November 18, 1958, in the Cleveland Engineering and Scientific Center featured comparisons between Indian and American ways of doing things. The panel for this program consisted of: J. E. Heyworth, superintendent mechanical department, Republic Steel Corp.; Amarjit Singh (known as Joe), electrical dept., Hindustan Steel (Private) Ltd., graduate engineer of Fresno State College; I. N. Tull, superintendent, electrical dept., Republic Steel Corp.; M. S. Bedi, mechanical dept., Hindustan Steel (Private) Ltd., graduate engineer of Michigan State College, S. B. Ray Chaudury, mechanical dept., Hindustan Steel (Private) Ltd., graduate engineer Jadav Pur University; C. Akbar, mechanical dept., Hindustan Steel (Private) Ltd., graduate engineer of Andhra University, and A. K. Mitter, electrical dept., Hindustan Steel (Private) Ltd., graduate engineer of University of Roorkee. The Indians who were on this panel are members of the INSTEP program under which the American steel industry has been helping train Indian engineers and operators in modern ways to run a steel plant. The AISE has been of assistance in this program through furnishing technical information, standards and literature. The Cleveland section has been particularly helpful to the Indians. As a result many of the INSTEP group who were not previously members of the AISE have seen fit to join.

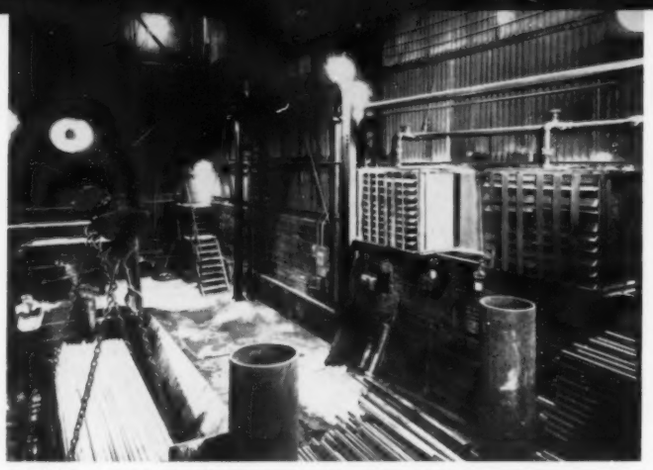


Figure 1 (left) — Overhead heaters with 4-way discharge outlets heat these two storage and shipping bays (378 x 86 ft each). Heater at end functions as door heater to warm up truck loading area. Figure 2 (right) — Two fog eliminators are mounted in wall to blow heated air over pickling and rinsing tanks to dissipate the fog created when steel pipe is raised out of hot tank. Chain slings are used in matched pairs of different lengths so that liquid will drain out of pipe. Dye-house exhaust fans on adjacent walls exhaust moist air to outside.

Pipe Mill Solves Variety of Heating Problems

THE variety of heating and ventilating problems in a large steel pipe mill called for the installation of equipment of sufficient flexibility to overcome such situations as process heat concentrated around furnaces which set up hot and cold air pockets, fog produced by many pipe dipping operations, large freight and truck loading doors opened frequently where workers are occupied, high ceilings and large areas, and finished pipe which must be protected against rust and corrosion in storage.

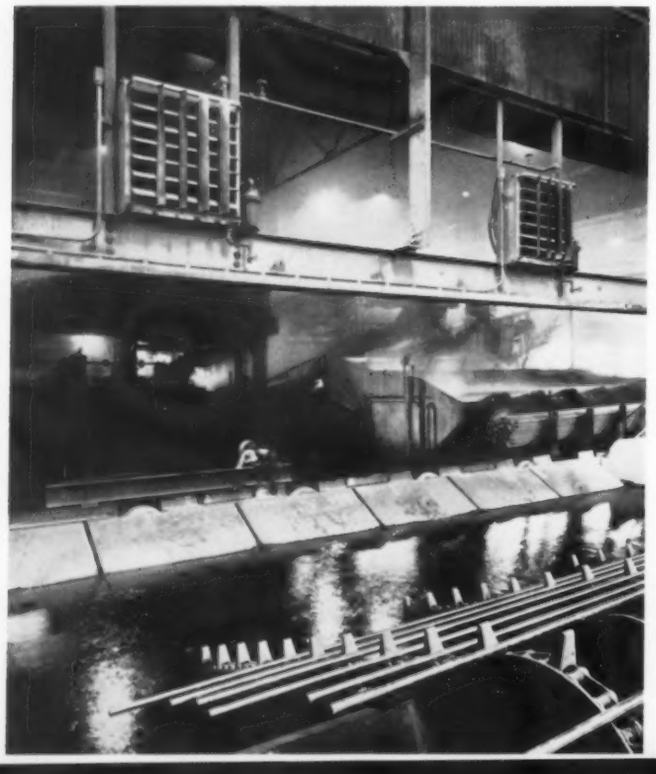
At the Spang-Chalfant Division, National Supply Co., Etna and Ambridge, Pa., plants, these problems were met successfully by the installation of various types of overhead heaters and fog eliminators made by the L. J. Wing Mfg. Co., Linden, N. J.

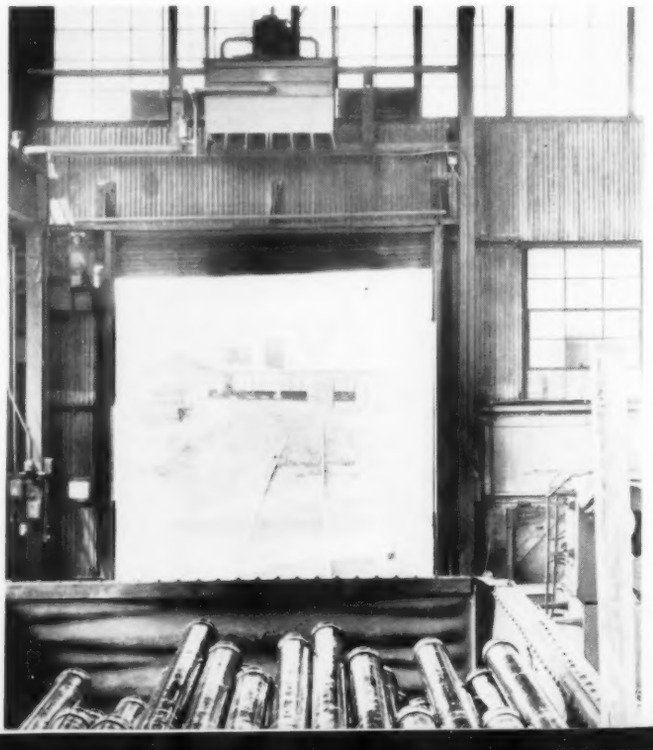
In the finished stock warehouse, and shipping department for small diameter electrical conduit, the two main bays (each 378 by 86 ft) are heated by ten Wing overhead revolving heaters with 4-way discharge outlets (Figure 1).

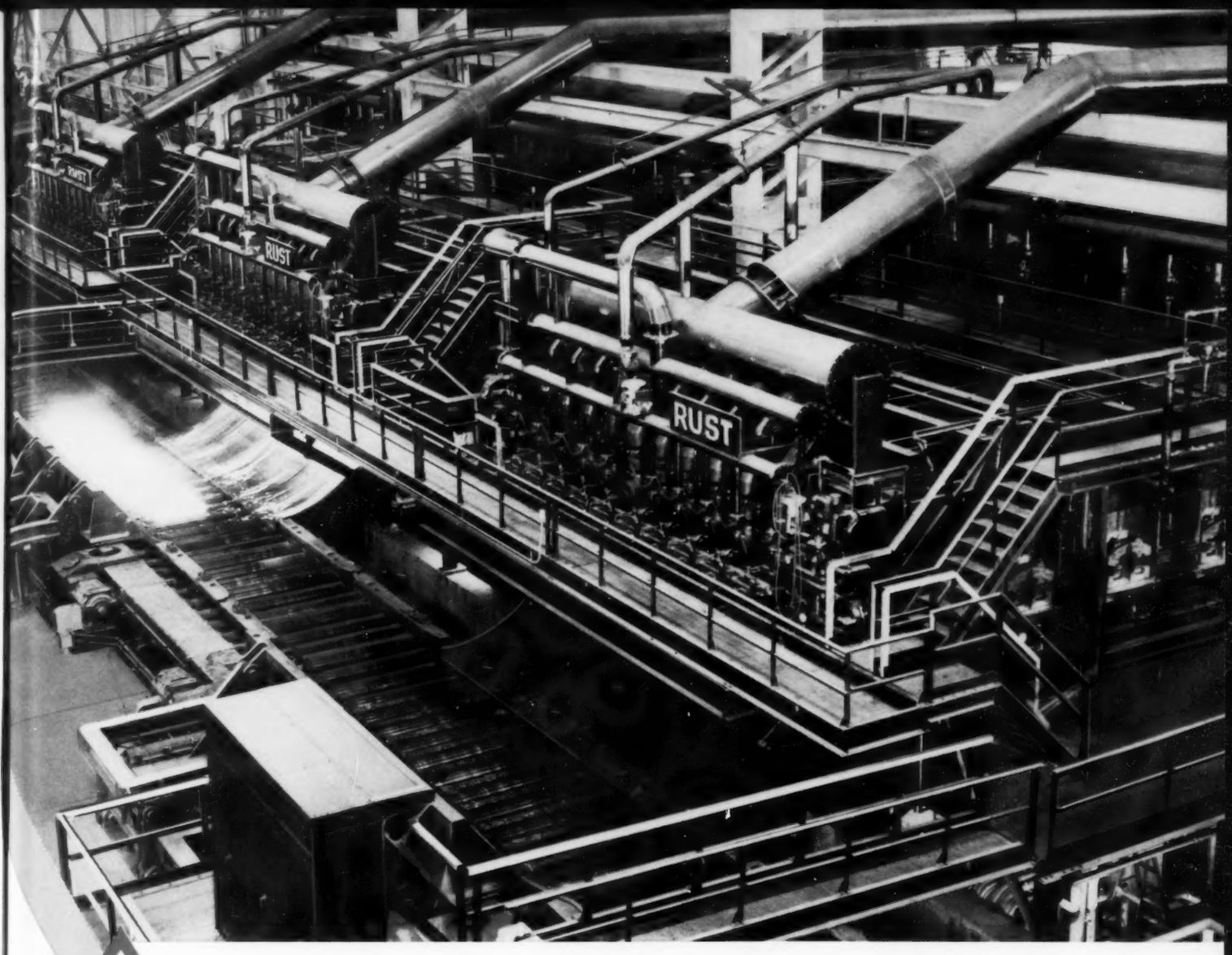
The steam coils in the heaters are located between the fan on the top and the discharge outlets on the bottom. The fan blows air through the coils and down to the working level through the discharge outlets.

The finished pipe is stacked high in racks to make economical use of space. However, the heated

Figure (left) 3 — Two fog eliminators make use of hot air from gas furnace operations in adjoining bay, blowing air over the rinsing tanks, eliminating undesirable fog conditions previously encountered. Figure 4 (right) — Door heater mounted over freight doors in shipping department at the Spang-Chalfant Div. of National Supply Co., Etna, Pa., will curtain off outside wintry blasts. Heater over the door is electrically connected to door so that heater goes on automatically when door is opened to provide warm air curtain which warms outside cold air filtering through to provide comfortable inside weather conditions. Heater is thermostatically controlled when door is shut.







Triple-Fired Continuous
Slab Reheating Furnaces

For KAISER STEEL CORP. 86″ Hot Strip Mill, Fontana, Calif.

THREE completely AUTOMATIC gas-fired RUST FURNACES, designed and constructed for Kaiser Steel Corporation's Fontana Works. Each furnace is designed to heat cold slabs to rolling temperatures at a rate of 150 tons per hour. Internal dimensions of furnaces: 24′ wide x 100′ long. Metallic recuperators minimize fuel consumption. This zone-fired type of Rust furnace is used by virtually all strip mills throughout the world. Consult us about your furnace requirements – melting, reheating or heat treating.

THE WHOLE JOB IS ONE JOB WITH A "RUST PACKAGE CONTRACT"

One contract covers everything from original idea through furnace start-up. One responsibility for design, manufacture, erection and initial operation. One overhead and profit (with substantial savings to you) on all phases of the work, including wiring and piping.

RUST FURNACE COMPANY

930 Fort Duquesne Boulevard, Pittsburgh 22, Pa.

Pioneers in Furnace Design

air streams flow down from above and reach all sides of the stored material. With uniform heat local cold spots and moisture accumulations leading to rust and corrosion are avoided.

Two Wing high velocity door heaters are placed near the doors at the shipping department end of the building where highway trucks park within the building for loading. These units temper the incoming cold air blast and raise the temperature of the area around the doors back to normal within a short time after the doors have been closed.

Adjoining the main bays is a 24-ft-wide extension built to accommodate four freight cars. Four heaters have been installed in this bay. Heat is concentrated in this small area for two reasons: (1) the doors are opened frequently to move freight cars, and (2) there are many air changes per shift. In addition, when an empty freight car comes into the building from the outside, it brings in a mass of cold metal which would cool off the area if the heaters were not available to raise the temperature of the cars. Each heater is controlled by a room thermostat so that each heater responds to temperature conditions in its own area.

Adjacent to the storage building is the pipe cleaning and pickling department consisting of three hot tanks. The problem here is fog. When the pipes are raised out of the tanks, steam is given off which amounts to a heavy fog. If not dissipated, it causes worker discomfort, obscures vision and leads to rusting and corrosion of equipment and finished pipe. To correct this condition, two Wing fog eliminators have been installed (Figure 2). In each unit, a fan blows outside air through steam-heated coils horizontally over the tanks. The heated air raises the air temperature over the tanks so that fog does not form. The moisture-laden air is removed from the building by five Wing dye-house fans. The exhaust fans prevent the moist air from flowing out into the finished stores section. The pickling section is 112 ft long and 58 ft wide. An additional overhead heater is mounted over stored material near the tanks.

Three fog eliminators mounted in wall blow heated air over eleven tanks in galvanizing department to eliminate fog. Moist air is exhausted through the large hood and blower over the galvanizing furnace.

Two fog eliminators are placed over a hot water rinse tank in a bay adjoining a furnace operation (Figure 3). The fog eliminators make use of some of the hot air given off by the furnace as they draw air from the furnace bay and blow it through the steam coils and over the rinsing tank.

Four more fog eliminators are used with galvanizing unit No. 3. Here four heaters are mounted in the end wall and blow heated air over eight pickling and rinsing tanks. The moist air is exhausted through roof monitors.

The shipping department for large diameter pipe presents a complex heating problem. There are three freight car doors in the end of the building; there is no source of process heat and a large hydraulic testing machine is near the doors. Testing is the last step in processing before storage or shipment. In addition to overhead heaters placed in the roof trusses of the three bays leading to the shipping area, special door heaters are mounted over each freight car entry door (Figure 4). These units blow heated air straight down setting up a warm air screen that tempers the cold air entering the building. These heaters also serve to warm up the freight cars which, when brought in at low temperatures reduces the temperature of the area.

Special steps have been taken to make sure that the water used in the hydraulic testing machine does not freeze. One of the high ceiling discharge heaters is placed over the machine. In addition, a low ceiling revolving heater has been installed between the two freight car doors near the tester.

Because of the expansion of the mill buildings in an urban area, it was necessary to provide a passageway for the company-owned railroad tracks through one of the main mill buildings to service the shipping department of the small diameter pipe mill. A door heater was installed over each door to temper the inrushing cold air. Formation of ice has been eliminated and the building stays close to a comfortable 70F. ▲

How to Sidestep Obsolescence

By upgrading plant equipment now, while demand is low, you can sidestep future obsolescence and be ready for tomorrow's production peaks. An important part of this program can be General Electric's new packaged, adjustable-speed drive—the Speed Variator.

Because of its wide speed range and precise regulation, it is ideal for modern, high-speed production. For example, in processing lines, rolling and tube mills, the Speed Variator maintains speeds automatically, accelerates and decelerates smoothly, controls tensions accurately.

New Amplistat Regulator and Static Exciter, standard on all new G-E Speed Variators, have no moving parts. As a result, maintenance costs are reduced.

To find out how the Speed Variator can help you obtain maximum drive flexibility, call your General Electric Sales Engineer, or write for GEA-6643. *Direct Current Motor & Generator Department, Erie, Pa.*
813-19

Progress Is Our Most Important Product

GENERAL ELECTRIC

5 REASONS WHY YOU SHOULD BUY—

New General Electric Speed Variator

1. **Amplistat Regulator** offers better speed regulation and adjustable, timed acceleration for improved product quality.

2. **Static Exciter,** with silicon rectifier, has no moving parts, requires no warm-up, provides more production time, less maintenance.

3. **Two-Unit, Four-Bearing M-G Set** features Tri-Clad† '55' motor for more dependable performance.

4. **Front-Connected Controls,** recessed wiring troughs make routine inspection easy, cut maintenance time.

5. **Kinamatic* Drive-Motors** provide instant response to control signals. For details on this fast-acting motor see next page.

For more information contact your Apparatus Sales Office or write for GEA-6643. *Direct Current Motor & Generator Department, Erie, Pennsylvania.*

In Canada, contact Canadian General Electric, Peterborough, Ontario.

† *Registered Trade Mark General Electric Co.*
* *Trade-Mark of General Electric Co.* 813-9

GENERAL ELECTRIC

More On Kinamatic Motors

NEW GENERAL ELECTRIC DC MOTOR GIVES

Instant Working Power

KINAMATIC* . . . a new standard in industrial direct current motors . . . designed to deliver drive power at the moment you need it!

Split-Second Response . . . larger air gaps reduce electrical time constants . . . smaller armature diameter permits more rapid delivery of torque to load . . . means faster starts, stops, reversals.

Low Inertia Armature is dynamically balanced, banded with steel and glass . . . gives dependable, high-speed operation . . . skewed armature slots minimize torque pulsation, permit smooth machine operation at low speed.

Other Power Packed Features of new d-c Kinamatic motors help give you more continuous, more automatic production . . . economically.

Additional information is available at your nearest General Electric Apparatus Sales Office. Or, if you prefer, write for Bulletin GEA-6355. *Direct Current Motor and Generator Department, Erie, Pennsylvania.* 813-9

*Trade-Mark of General Electric Company.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Selecting Fire Resistant Hydraulic Fluids

THE present complexity of the field of fire-resistant hydraulic —four types, a dozen suppliers, 30-odd brand names, varying prices and degrees of fire resistance—places growing responsibility upon suppliers of these products to assist users in making the proper selections.

Acting on this premise, E. F. Houghton & Co., Philadelphia, supplier of all four basic fluid types, attempts to spell out, through applications research, the salient differences among fluids.

The actual reason for the wide range of fluids now available is simply that no one fluid has the universal characteristics of petroleum oil. In fact, every fire-resistant fluid has characteristics markedly different from oil which can lead to unsatisfactory hydraulic performance. But by correlation of fluid properties with design characteristics of a system, the Philadelphia firm claims it can pinpoint the fluid type which will perform best with little or no system re-design.

PUMP PERFORMANCE

Phosphate esters are the most widely applicable. But they cannot be used with equal success in all types of equipment. In certain pumps, for instance, neither esters nor water-glycol fluids are fully satisfactory. Restricted pump intake conditions are aggravated by the high density of the fluid. These pumps should be modified to handle the fluids.

A fire-resistant fluid should be chosen only after a study of equipment details. Fluid performance can be predicted if sufficient equipment data are at hand.

BEARING FATIGUE STUDIES

A flat statement that phosphate ester fluid provides better bearing life than water-glycol is not justified, according to the following results of tests run by Houghton hydraulics engineers:

1. Balanced vane pumps have negligible bearing loads so have no bearing trouble when operating with water-glycol fluids.

2. Most axial piston pumps have sufficient bearing capacity to use water-base fluids satisfactorily.

3. Some gear-type pumps have inadequate bearing capacity for good use of water-base media. But those with plain bearings do well.

4. Water-base media perform poorly in radial piston pumps, due to inherent rust problems within the pump case, and to the shorter bearing life which results.

5. Screw-type pumps perform well with water-base fluids.

In general, pumps with plain bearings perform best with water-base fluids. Unbalanced vane and gear pumps can be modified with plain bearings to improve operation with water-base fluids. Other pumps can be modified with higher capacity anti-friction bearings.

PACKING COMPATIBILITY

According to Houghton, there is ample data now available from several sources to help users achieve a high degree of fluid-packing compatibility. Essentially, water-glycols have no affect on standard rubber or leather packings unless the pH rises to a high level. They do affect cork composition shaft seals, but these can usually be replaced with rubber.

When using a phosphate ester fluid, special attention should be given to packings and seal materials:

1. Dynamic seals should be butyl rubber, silicone, or teflon.

2. Static seals are not critical.

3. Packing changes, especially dynamic seals, should be made at the time of installation of the fluid.

The most apparent indication of fluid-packing incompatibility is packing swell. Swell varies widely among various fluids and packings, as indicated by results of ASTM Rubber Swell Test in Table I.

TABLE I
Per Cent Volume Increase After 168 Hours at 158 F

Fluid	Packing		
	Butyl	Buna N	Duck and neoprene
Phosphate ester A	3	89	30
Phosphate ester B	30	77	48
Phosphate ester C	37	92	57
Phosphate ester D	3	68	35

Taking 15 per cent as a recommended maximum swell figure, it is apparent that Buna N packings and phosphate ester fluids are incompatible. This is also true of the esters with the fabricated duck and neoprene.

Analysis of the above esters for content of chlorinated materials has shed light on the wide differences in swell between esters A and D, B and C. Fluids B and C contain appreciable amounts of chlorinated materials which accounts for their deterioration.

TENDENCY TO CREATE RUST

Phosphate ester fluids do not contribute to the formation of rust or corrosion. However, unless fortified with conventional petroleum type rust inhibitors, they do not offer protection against rust in wet or humid conditions.

Water-glycol media have a corrosive affect on zinc and cadmium. But at proper pH they have proved entirely acceptable in contact with other metals. Contamination or prolonged overheating above 150 F sometimes depletes additives and lowers pH. This can be avoided by periodic checks of the fluid during service.

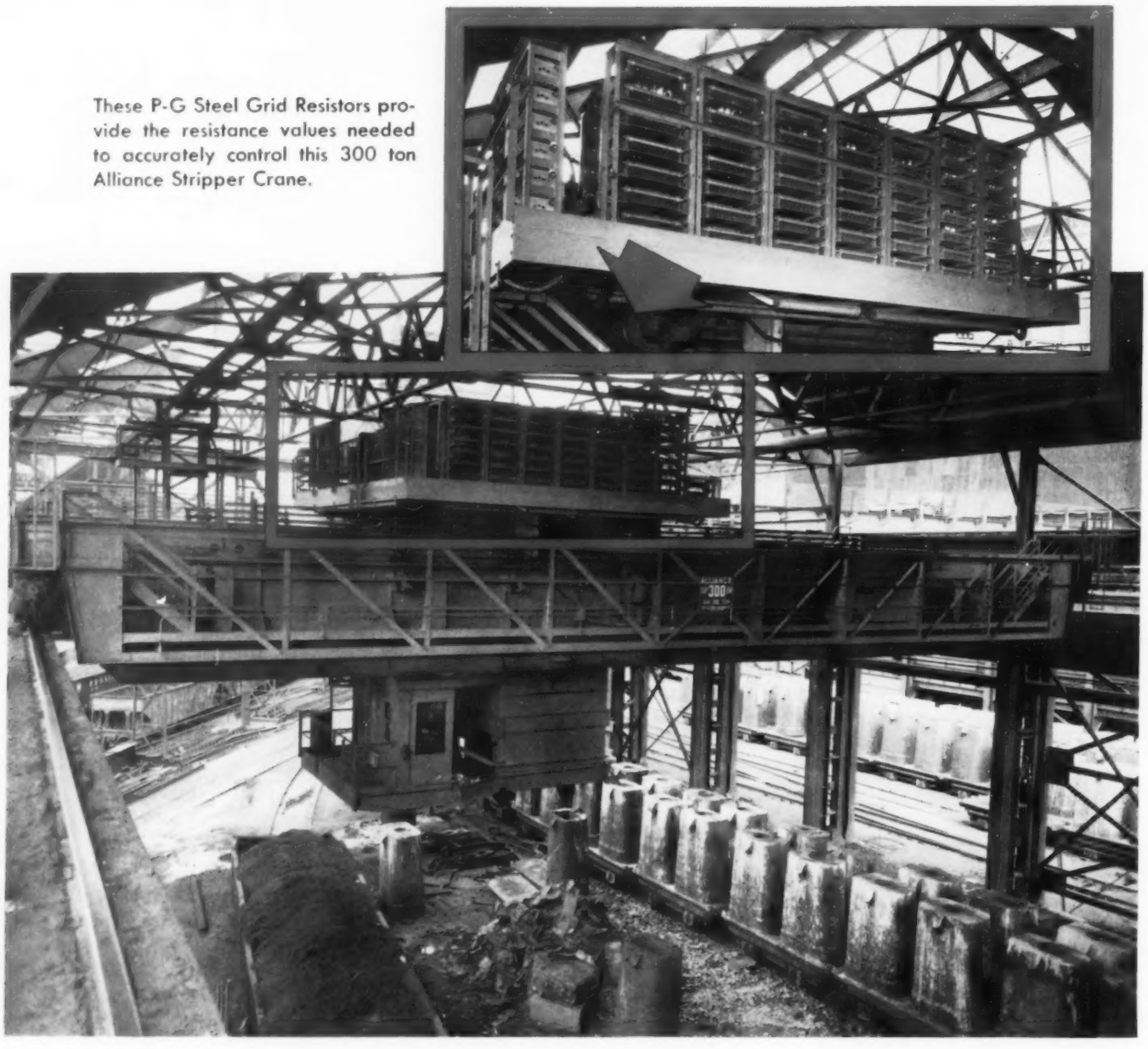
FIRE RESISTANCE

Suppliers rate the fire resistance of their fluids on the basis of various flammability tests such as spraying samples through an ignition source, or pouring samples on molten metal. There is not as yet a significant degree of standardization among these tests. But Houghton has drawn several conclusions, from their own data and that published by other suppliers, which can be profitably applied by potential users:

1. Phosphate esters—excellent fire resistance in contact with hot surfaces. In direct contact with flames they flash at relatively low temperatures (470 F), but do not readily propagate flame after ignition.

2. Water-glycols—excellent fire

These P-G Steel Grid Resistors provide the resistance values needed to accurately control this 300 ton Alliance Stripper Crane.



P-G Resistors constantly prove their value on this 300 ton stripper crane . . .

P-G Resistors give trouble-free service on this stripper crane at Weirton Steel Company, division of National Steel Corporation at Weirton, West Virginia.

These rugged non-breakable resistor units built of steel and mica, plus P-G exclusive design have proved their worth in various types of service for more than 20 years.

For the maximum in resistor value try P-G the ORIGINAL Steel Grid Resistor for continuous service on stripper cranes and all other steel mill applications.

Write for Bulletin No. 500

Established 1892

P-G

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—**Kenton Lands Road, Erlanger, Kentucky**

MAILING ADDRESS—**Box 709, Covington, Kentucky**

resistance in contact with hot surfaces over 1,000 F but usually burn with low flame.

3. Water-oil emulsions—less fire-resistant than other types but still safer than petroleum oils. Valuable for lower hazard applications.

OUTLOOK

All types of fluids now on the market will increase in usage, reports Houghton. New types of water-base media will appear and new variations of non-aqueous fluids will also be developed. Additive fortification will be used to a greater extent.

As the field continues to expand, it will become imperative for suppliers to consistently apply certain basic measures in order to match fluid medium to application.

1. Check every installation thoroughly before a fluid is chosen.

2. Analyze complete specifications and operating conditions of the hydraulic system. This should be done by hydraulic engineering specialists.

3. The specialist can then recommend both fluid and any modifications necessary for the system.

In this way a new degree of certainty in the specification and use of fire-resistant fluids will be achieved. ▲

New Variable Speed Drive Line Features Reduced Space Requirements

A COMPLETELY new line of variable-speed drives for industry have just been unwrapped by Reliance Electric and Engineering Co., Cleveland. Called the "Super 'T' V*S Drive," the new packaged drive systems reveal size reductions up to 35 per cent over comparable existing drive units from three to 350 hp.

The new drives, which have the same basic functions as existing industrial variable-speed units, have been designed around the newly redesigned NEMA a-c and d-c motors and generators. These new rotating machines, with higher-temperature Class "B" insulation throughout, are much smaller than previous units. This compactness on the part of the rotating elements, plus improved cabinet ventilation techniques, has permitted Reliance engineers to decrease the over-all control unit dimensions.

In conjunction with Reliance Super "T" variable-speed drive motors, the new V*S Drives will commutate up to 200 per cent current for periods of one minute, and will handle even higher transitory peak loads. The Super "T" motor is supplied as standard with the new Super "T" V*S Drives. The motor features Class "B" insulation and a 60 C rise.

The new drives are offered in two basic styles—standard and custom. If the operating requirements are extremely complex, the custom control unit will be supplied. In normal industrial applications, the standard packaged system will be offered. Both styles are engineered to meet NEMA I, IA, 5, 12 and J.I.C. specifications.

Besides improved ventilation, both styles of control cabinets are pressurized to prohibit the entrance of dust and external airborne dirt particles. All ventilating air drawn into the cabinets is thoroughly filtered by oil-type, rechargeable filters.

All leads are numbered to correspond to those on the wiring diagram. Exclusive Reliance Sealpak construction, with complete component circuits embedded in solid blocks of plastic, is used throughout. Channel wiring is featured on all control units.

The new drives feature a preset speed control device, and timed acceleration and deceleration. Speed control is available over an 8:1 range by armature voltage, and over a 4:1 range by field control.

A variety of operator's stations are available, including independent mounting stations, flush-mounted stations, and explosion-proof stations for operation in hazardous atmospheres.

The variable-speed drive motor may be specified in a range of standard speeds. Standard enclosures and mountings are available. ▲

Figure 1 — Height of men illustrates compact size of new drive control cabinet (right), with fully removable door. Old-line cabinet of same horsepower size is at left. Both front and rear panels on the new drive control unit can be completely removed for ready access to components.

Figure 2 — Service is easy on the new drives, as shown here with front panel removed. Compact new motor-generator set at bottom features Class "B" insulation. All control components are exposed for maintenance.

When a motor we installed single phased, — Fusetron Fuses saved our reputation and a $200 rewind job

C. B. Meldrum, OWNER
MELDRUM ELECTRIC COMPANY
HOUSTON, TEXAS

Mr. Meldrum continues:

"Recently I sent several of my men to install a 50 h. p. air conditioning unit for a customer.

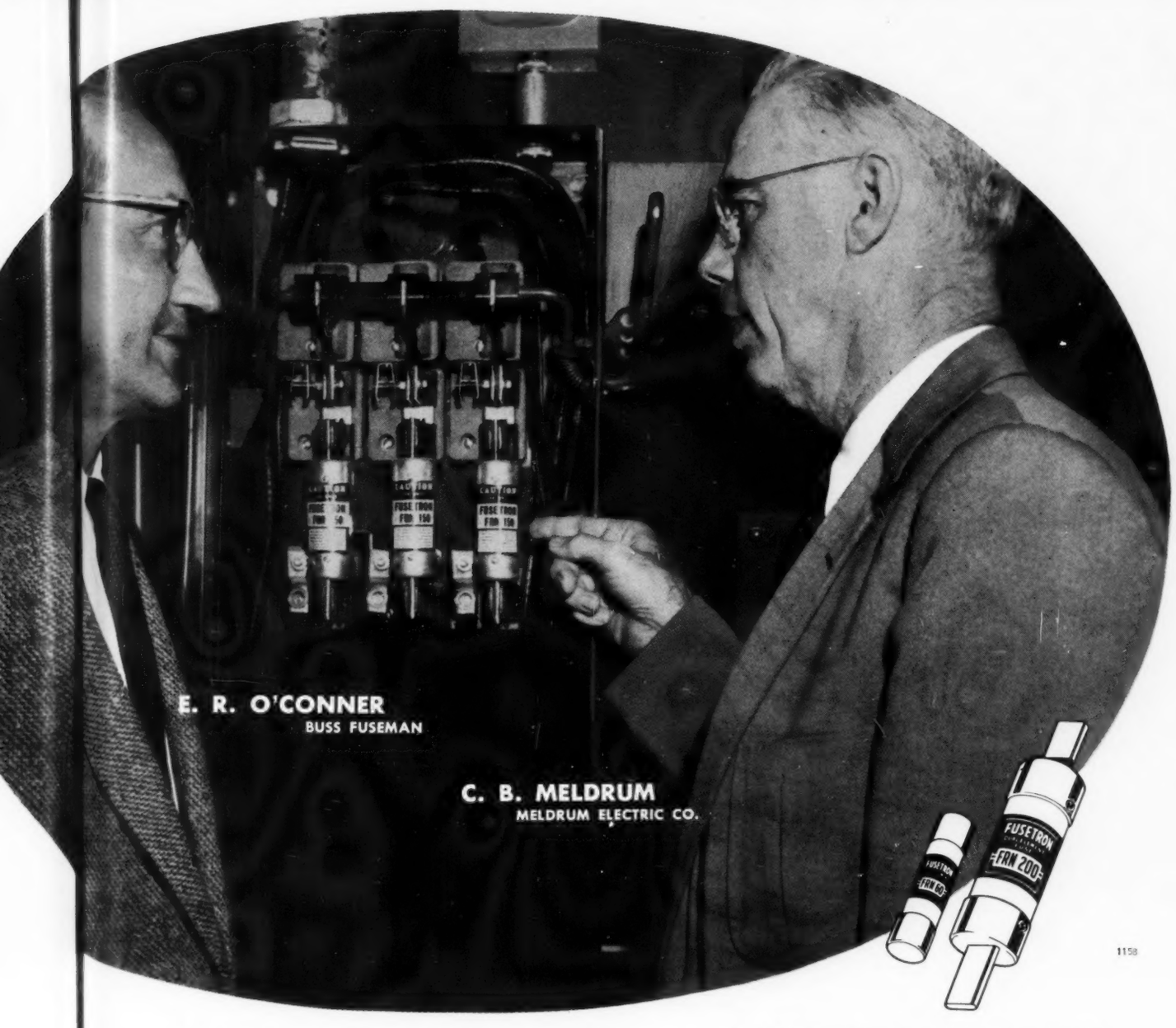
"It seems that my man who wired the 200 amp. switch failed to tighten a lug. He just hung the wire on the lug and then forgot to tighten it.

"When the unit was started, it didn't take long for trouble to develop. The loose connection caused one Fusetron fuse to blow. The motor started to run single phased but before any damage could result the other Fusetron fuses protecting the motor also blew and shut down the motor.

"My company stands behind its work. If the motor would have burned up, we would have rewound it without question. I know this would have cost us at least $200.

"What is important too, our reputation was saved and we have a satisfied customer. If the Fusetron fuses had not given us an opportunity to go back and do the job right before the motor was damaged, we would have been in a 'hot' spot."

For safe, modern, money-saving protection install FUSETRON dual-element FUSES and BUSS Hi-Cap FUSES throughout entire Electrical System!



Why Fusetron Fuses Provide Safest, Simplest Way to Prevent Damage from Single Phasing

When single phasing occurs, the current in the remaining phase increases about 100%. (Theoretically 73% but change in efficiency and power factor makes it about 100%.

This 100% overload on Fusetron fuses of motor-running protection size opens them and shuts down the motor.

Such dependable protection against motor burnouts from single phasing has never before been available.

You too, Can Get Safer, More Dependable and Money-Saving Protection with Fusetron Fuses

FUSETRON dual-element fuses provide 10 point protection against electrical troubles. This is unlike circuit breakers or ordinary fuses which, except in rare cases, protect only against short-circuits.

In Addition: Fusetron Fuses Require No Maintenance or Recalibration

They are calibrated at the factory by engineers. Once properly installed, they require no inspection or down-time necessary on mechanically operated devices. There are no hinges, pivots or contacts to stick or get out of order. Dust, corrosion or oxidation cannot increase a Fusetron fuse's capacity or lengthen its blowing time.

After years of inactivity, a Fusetron fuse will give the same safe, dependable protection if called upon to open as it would have on the day it was installed.

For Loads above 600 and up to 5,000 amps . . . Use BUSS Hi-Cap Fuses

They have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

for more information, write for . . . **Bulletin FIS on Fusetron fuses**
Bulletin HCS on BUSS Hi-Cap fuses.

BUSSMANN MFG. DIVISION – McGraw-Edison Co. *University at Jefferson, St. Louis 7, Mo.*

FUSETRON · TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION · BUSS · McGRAW EDISON · BUSSMANN MFG. DIVISION · St. Louis 7, Mo.

Figure 1 — Operating side of 48-in., five-stand tandem tinplate mill. Automatic gage control, incorporated as an integral part of the mill control and regulating system, insures uniform strip thickness and minimum off-gage strip. The mill operates up to 6000 fpm, and has 22,500 hp total main drive capacity.

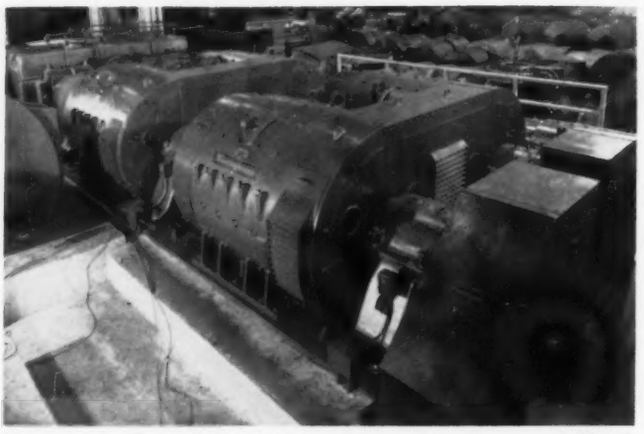


Figure 2 — The 6000-hp, twin-motor drive for stand No. 5 consists of two 3000-hp, 250/550-rpm, 750-volt, double-armature motors. The 1500-hp units are of special frame design for minimum inertia. The two 3000-hp motors may be assembled on a common base on 67½-in. centers.

Automatic Gage Control Is Applied On New High Speed Tandem Tinplate Mill

by Alonzo F. Kenyon, Advisory Engineer,

Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

AUTOMATIC gage control is utilized on the new five-stand tandem tinplate mill at Wheeling Steel's Yorkville, Ohio, plant. The control minimizes off gage strip at the beginning and end of the coil. The new mill is 48 in. wide, and will produce tinplate and heavier gage strip at speeds up to 6000 fpm. The mill and reel main drives total 22,500 hp. Eleven main power supply generators are assembled on two motor-generator sets, each driven at 514 rpm by a 12,000 hp, 13,200-volt synchronous motor.

With the automatic gage control, strip thickness is continuously gaged and recorded; through feedback signals the mill is automatically adjusted to correct variations in the entering hot strip. A thickness gage between stands No. 1 and No. 2 controls the No. 1 stand screwdown and assures uniform strip to the rest of the mill.

A second gage, between stand No. 5 and the winding reel, measures the thickness of the delivered strip. It controls the No. 5 stand and the reel to adjust strip tensions and maintain constant gage of the finished strip.

The mill and reel drives are described in Table I. ▲

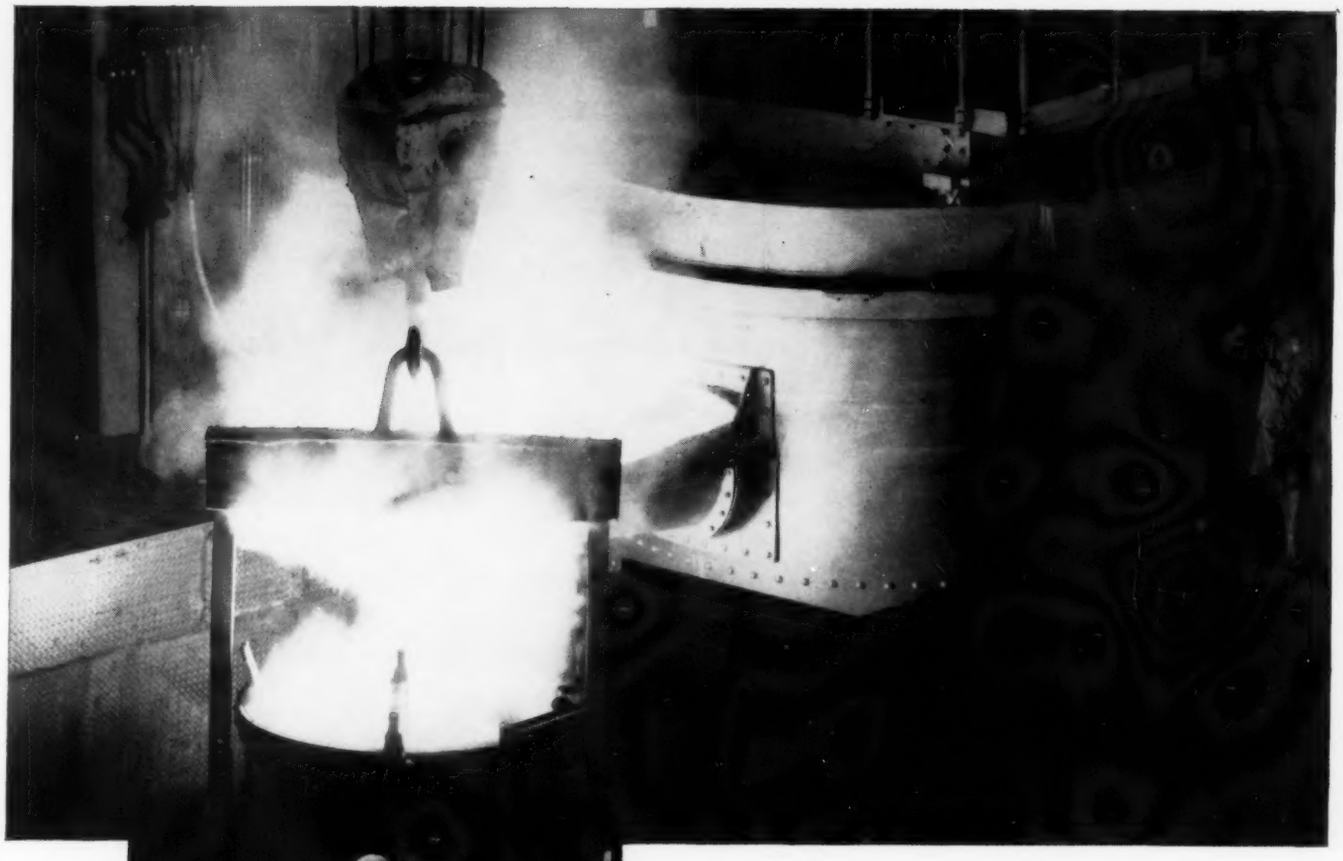
TABLE I

Mill and Reel Drive Unit Data

Application	Machine type	Rating			Comments
		Output, hp	Voltage	Speed, rpm	
Stand No. 1	Single-armature motor	2000	750	90/270	Directly driving the pinion stand
Stand No. 2	Double-armature motor	4000	750	150/375	Directly driving the pinion stand
Stand No. 3	Two single armature motors	2000 each	750	150/375	4000-hp twin drive Output applied through one-to-1.51 step-up gears
Stand No. 4	Two single armature motors	2500 each	750	250/518	5000-hp twin drive Output applied through one-to-1.51 step-up gears
Stand No. 5	Two double-armature motors	3000 each	750	250/550	6000-hp twin drive Output applied through one-to-two step-up gears
Winding reel	Triple armature motor and magnetic brake	1500	600	300/1120	Directly coupled to the 20½-in. reel mandrel

PROGRESS IN ROLL MAKING

electric melting for large steel rolls



Preparing mold for grooved steel roll.

NEW—

THE ELECTRIC FURNACE you see has recently been installed in our new steel foundry building for the production of *large* steel rolls.

To meet customers' specific requirements for every roll use, National now has a wide range of sizes of electric furnaces permitting controlled metallurgical composition regardless of roll size.

The new electric furnace is typical of big things that are happening at National—new facilities, new equipment, new processes to give you better, longer lasting rolls. Specify National rolls.

GENERAL STEEL CASTINGS CORPORATION

National Roll & Foundry Division

Avonmore (Westmoreland County) Pennsylvania

General Steel Castings Corporation: General Offices, Granite City, Ill.

Plants: Granite City, Ill. — Eddystone, Pa. — Avonmore, Pa.

WORLD'S LARGEST LADLE CRANE-525 TON

(built by Alliance . . . naturally)

CAN LIFT THE EQUIVALENT WEIGHT OF ALMOST 2 MILES OF AUTOMOBILES

"Give us the Runway and We'll Lift the World"

Alliance

• Alliance engineers have incorporated the use of special alloy steels in the construction of the biggest ladle crane yet — a 525 tonner to be installed at United States Steel's Fairless Works Division. Use of these special metals, where practical, results in reduction of wheel loads, and permits installation on existing runways now carrying 450-ton cranes. This keeping ahead of all facets of crane design-engineering has established Alliance as the leader in the big crane field. Why not talk to the Alliance engineers in Alliance or Miami? They'll help solve your material handling problems quickly and economically.

THE ALLIANCE MACHINE COMPANY

MAIN OFFICE • ALLIANCE, OHIO BRANCH OFFICE • MIAMI, FLORIDA

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB & BILLET CHARGING MACHINES
OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION • COKE PUSHERS • LOADING AND UNLOADING TOWERS

Johns-Manville Insulating Fir

put physical and thermal properti

in proper balance!

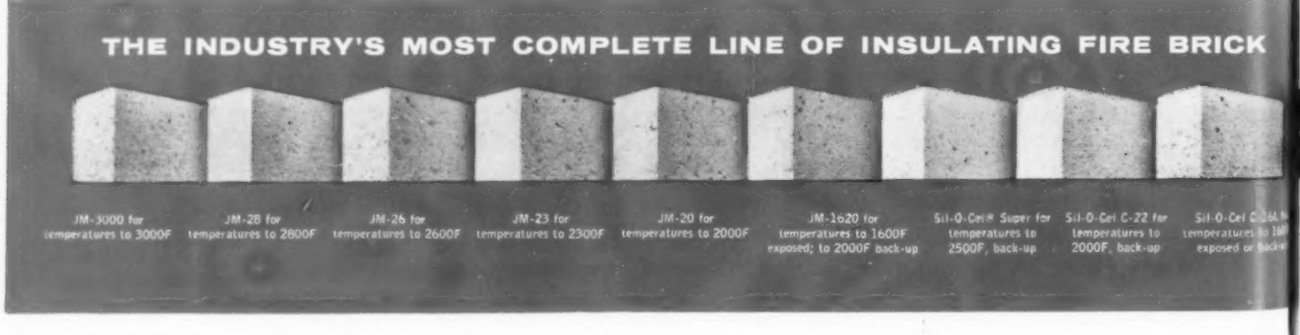
...provide essential high-temperature resistance and low conductivity...yet maintain high load-bearing strength with low spalling!

Only Johns-Manville's insulating fire brick family offers the right combination of properties to meet the diversified requirements of modern furnace construction.

Johns-Manville's nine different insulating fire brick mean you never have to settle for a brick that's nearly right! Instead you choose the one insulating fire brick or combination of brick that best meets your specific requirements for temperature resistance, load-bearing strength, conductivity and density.

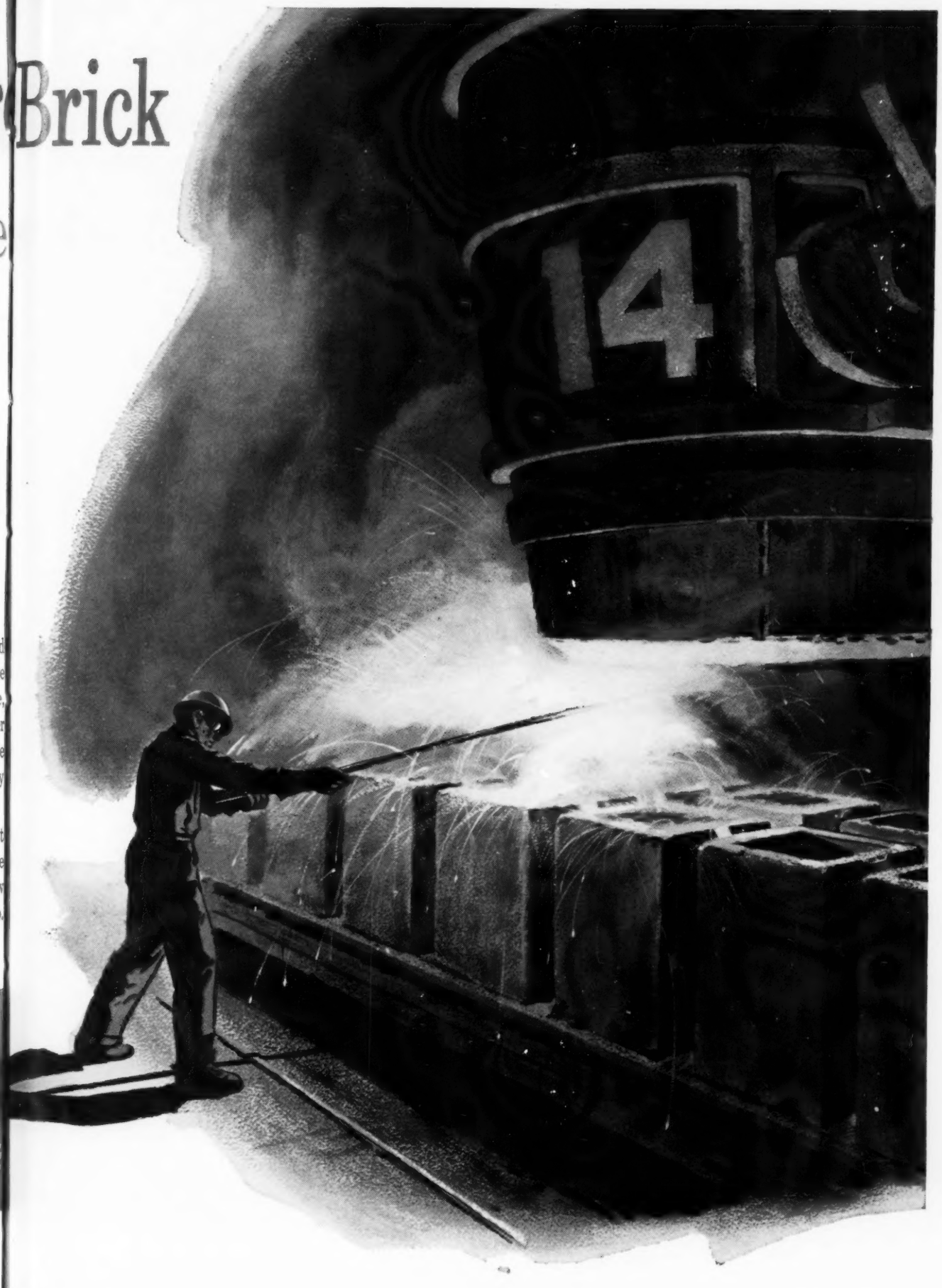
Johns-Manville has two strategically located plants for the production of insulating fire brick: Lompoc, California and Zelienople, Pennsylvania. Insulating fire brick and other Refractory Products are available from the stocks of Authorized J-M distributors in key industrial areas.

For further information, call your nearest J-M representative. Or write for brochure IN-115A to Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.


THE INDUSTRY'S MOST COMPLETE LINE OF INSULATING FIRE BRICK
JM-3000 for temperatures to 3000F
JM-28 for temperatures to 2800F
JM-26 for temperatures to 2600F
JM-23 for temperatures to 2300F
JM-20 for temperatures to 2000F
JM-1620 for temperatures to 1600F exposed; to 2000F back-up
Sil-O-Cel® Super for temperatures to 2500F, back-up
Sil-O-Cel C-22 for temperatures to 2000F, back-up

JOHNS-MANVILLE JM PRODUCTS

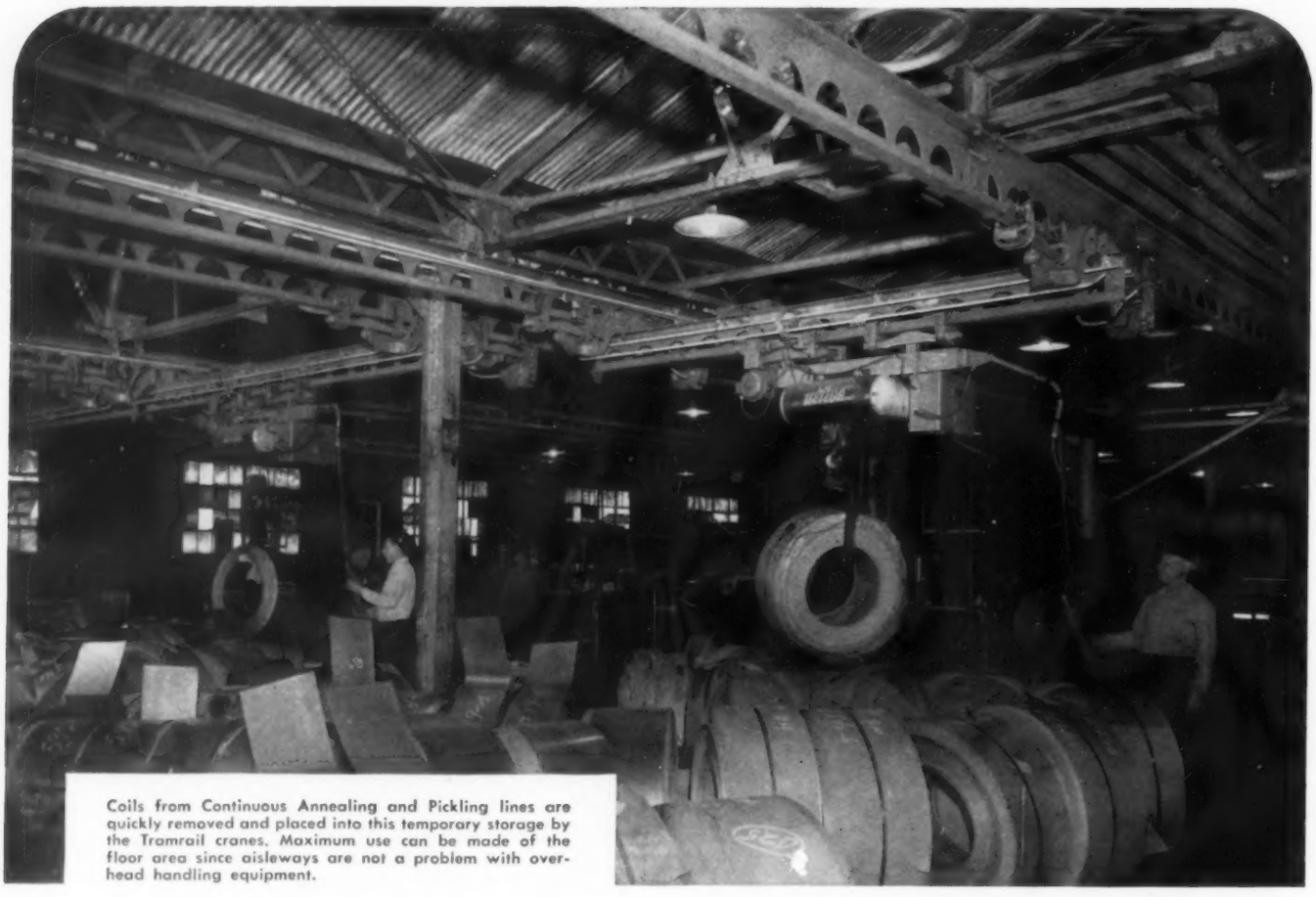
Johns-Manville REFRACTORY and



INSULATING REFRACTORY PRODUCTS

Tramrail Cranes BOOST Strip Production

Speed Handling—Cut "Down Time"—Aid Safety



Coils from Continuous Annealing and Pickling lines are quickly removed and placed into this temporary storage by the Tramrail cranes. Maximum use can be made of the floor area since aisleways are not a problem with overhead handling equipment.

AS a leading producer of high quality alloy strip steels, mostly of light gauge, the Superior Steel Corp., Carnegie, Pa. has secured definite production advantages and greatly improved overall plant efficiency through abundant use of Cleveland Tramrail cranes.

As the work is primarily that of rolling, annealing, pickling and handling, to obtain maximum production from their equipment, it is necessary to keep it in operation as many minutes out of the day as possible. This means that there be no delays in handling the coils of strip to and from the mills. It also means that the mill rolls must be changed in the least possible time. The Tramrail cranes have proven of great success in fulfilling these requirements and reducing "down time" to a minimum.

They have also proven to be a great aid to the workers' welfare. Being fully motorized, they have practically eliminated all manual lifting and moving. As a result, worker fatigue has been reduced and safety improved.

GET THIS BOOK!

BOOKLET No. 2008. Packed with valuable information. Profusely illustrated. Write for free copy

CLEVELAND TRAMRAIL DIVISION
THE CLEVELAND CRANE & ENGINEERING CO.
5083 EAST 284TH ST. WICKLIFFE, OHIO

CLEVELAND TRAMRAIL
OVERHEAD MATERIALS HANDLING EQUIPMENT

Date-line Diary...

November 3

Δ Instalment debt at September 30, 1958 totaled $33,100,000,000, which is $257,000,000 below total of September 30, 1957.

Δ Government figures showed that construction outlays for October, 1958 topped $4,700,000,000 a decrease of less than one per cent from September, 1958.

Δ The AISI reports that the operating rate of the steel industry for the week of November 3, is scheduled at 2,011,000 net tons (74.5 per cent of capacity). This compares with 2,024,000 tons one week ago (75.0 per cent capacity) and 1,996,000 tons one year ago. Index of production for the week is 125.2.

November 4

Δ Auto makers output of new cars in October reached 261,696 compared with 131,952 in September, 1958, but 20 per cent below October, 1957 output.

Δ Economists attending the sixth annual conference at University of Michigan predicted that national production in 1959 will reach $460,000,000,000, a rise of four to five per cent over the current rate. Living costs are forecast to increase only about one per cent.

November 5

Δ The Bureau of Mines reported that production of Pennsylvania anthracite for October, 1958 was 1,979,000 net tons compared with 2,084,000 in September, 1958 and 2,262,000 tons in October, 1957.

November 6

Δ According to the Association of American railroads Class I railroads income in September, 1958 increased $9,000,000 over September, 1957 to $73,000,000. Net for the first nine months of 1958 was estimated at $354,000,000, down $186,000,000 from the same period of 1957.

November 7

Δ Auto output this week is expected to reach 128,265 units, compared with 97,899 cars last week and 136,321 cars for the same period of 1957.

November 10

Δ The AISI reports that the operating rate of the steel industry for the week of November 10 is scheduled at 2,029,000 tons (75.2 per cent of capacity). This compares with 2,011,000 tons one week ago (74.5 per cent capacity) and 1,990,000 tons one year ago. Index of production for the week is 126.3.

Δ Auto dealers sales of new cars in October, 1958 totaled 292,000 cars compared with 255,600 in September.

Δ The Labor Dept. reported that new claims for unemployment compensation for the week ended November 1, numbered 11,100 to make a total of 288,200, compared with a total of 278,000 for the same period in 1957.

November 11

Δ The Labor and Commerce Depts. reported that employees working short weeks on October 15 numbered 1,200,000 compared with 2,300,000 last spring; unemployment totaled 3,800,000 in mid-October, a drop of 300,000 from mid-September; total civil employment rose by 677,000 to a level of 65,300,000.

Δ Canadian output of steel ingots in October, 1958 totaled 253,024 tons, compared with 372,737 tons for the same time in 1957; production of pig iron amounted to 229,530 tons, down from the 293,425 tons produced in the same period of 1957. Output for the first ten months of 1958 amounted to 3,447,460 tons of steel ingots and 2,502,740 tons of pig iron compared with 4,229,967 tons of ingots and 3,204,326 tons of pig iron in 1957. Drop is largely due to Stelco strike.

Δ Pittsburgh Coke & Chemical Co. reports for the third quarter ended September 30, 1958 gross income of $11,875,000, and net income of $272,000 or 14¢ per share; for the same period in 1957 figures were $13,816,000, and $825,000 or 62¢ per share. For the first three quarters of 1958 gross income was $33,575,000, income $715,000 or 34¢ a share; in 1957 gross income was $41,127,000, net income $2,477,000 or $1.87 a share.

November 12

Δ AISI preliminary report showed steel production during October increased sharply to 8,816,000 net tons of ingots and steel for castings, compared with 7,610,372 tons in September, 1958 and 9,197,717 tons in October, 1957.

Δ The Agriculture Dept. reported that farmers face a 5 to 10 per cent decrease in net income in 1959 due to an expected decline in 1959 soil bank payments and increase in payments for labor and machinery as well as somewhat lower crop prices because of market-depressing surpluses and slightly reduced price supports.

November 13

Δ Britain boosted its exports to the U. S. in October, 1958 to $73,000,000 compared with $63,000,000 in September, 1958 and $55,000,000 in October, 1957. Total exports rose to $747,000,000 an increase of $74,000,000 over September, 1958.

November 14

Δ The Labor Dept. reported that home building activities in October climbed to a seasonally adjusted annual rate of 1,260,000 units and compared with a pace of 1,220,000 in September, 1958 and 1,020,000 in October, 1957.

November 17

△ World copper stocks decreased 106,005 tons in October thus decreasing U. S. and foreign producers supplies of the metal to 268,775 tons. U. S. producers stock at October 31 totaled 128,490 tons, down 49,732 from September 30, 1958.

△ According to F. W. Dodge Corp. outlook statement, construction in 1959 will total $35,600,000,000, an increase of 3 per cent over 1958 estimated value of $34,700,000.

△ The AISI reports that the operating rate of the steel industry for the week of November 17 is scheduled at 2,005,000 tons (74.3 per cent of capacity). This compares with 2,011,000 tons one week ago (74.5 per cent capacity) and 1,945,000 tons one year ago. Index of production for the week is 124.8.

November 18

△ The Commerce Dept. reported that personal income eased to a yearly rate of $357,500,000,000 in October, a decrease of $300,000,000 from September, 1958 pace.

November 19

△ The ARCI reports that deliveries of new domestic freight cars in October, 1958 totaled 1591 compared with 2131 in September 1958 and 8295 in October 1947. Orders in October totaled 781 compared with 1582 in September, 1958 and 2202 in October, 1957. Backlog of cars on order as of November 1, 1958 stood at 23,670 compared with 24,982 on October 1, 1958 and 65,718 on November 1, 1957.

△ The Railroad Commission boosted production of Texas crude oil to a 12-day basis for December, an increase of 105,094 barrels daily over the mid-November level.

November 20

△ Financial report of Northwestern Steel & Wire Co. shows sales for the quarter ended October 31, 1958 amounted to $17,958,796, net income $1,407,876 or $0.56 per share compared with quarter ended October 31, 1957 with sales of $13,726,654, net income of $621,632 or $0.25 per share.

△ The Industrial Heating Equipment Assn. reported that new orders for industrial furnaces in October, 1958 were $3,104,677 compared with $4,847,000 in September, 1958. New orders for induction heating equipment in October, 1958 totaled $743,000, compared with $888,000 in September, 1958.

△ The Aluminum Assn. reported that primary aluminum production in the United States during October, 1958 was 137,419 short tons compared with 124,713 short tons in September, 1958 and 133,759 tons in October, 1957.

△ American Can Co. announced establishment of separate FOB prices for its cans at each of its 68 U. S. plants, departing from the prevalent standard industry practice of selling cans at the same average prices in each of two areas, east and west of the Rockies.

November 21

△ Office of Business Economics, U. S. Dept. of Commerce announced gross national product for the third quarter ended September 30, 1958 was at an annual rate of $439,000,000,000, up $10,000,000,000 over the quarter ended June 30, 1958.

△ Some steel scrap grades at Philadelphia are down $3.00 to $4.00 a ton, No. 1 heavy melting scrap sold between $36 and $37 a ton, previously price $40; No. 2 heavy melting scrap was quoted at $34 a ton, also off $3 to $4; No. 2 bundles are quoted at $24 a ton, off $1.

△ Bethlehem Steel Co.'s proposed merger with Youngstown Sheet & Tube Co. was blocked in Federal District Court at New York. The judge ruled that "there is a reasonable probability that the merger would, in violation of Section 7 of the Clayton Act, substantially lessen competition and tend to create a monopoly."

△ Auto assemblies this week will climb to an estimated 141,067 cars, compared with 117,634 units produced last week, but 7 per cent below output a year ago.

November 24

△ The AISI reports that the operating rate of the steel industry for the week of November 24 is scheduled at 2,003,000 tons (74.2 per cent of capacity). This compares with 2,000,000 tons one week ago (74.1 per cent capacity) and 1,846,000 tons one year ago. Index of production for the week is 124.7.

November 25

△ Custom smelters lowered prices for copper ¼¢ to 29¾¢ a lb.

△ The National Machine Tool Builders Assn. reported that orders of machine tools for October, 1958 were $28,000,000, compared with $20,000,000 in September.

△ Upturn in production was probably stimulated by efforts to beat price increases and does not necessarily indicate any substantial recovery in the industry.

November 26

△ Copper prices were trimmed ¼¢ to 29½¢ per lb in U. S.; spot copper in London declined more than 1¢ reflecting release of 7500 tons of the British government's stockpile in addition to an earlier release of 10,000 tons by this same source.

△ The AISC reports that bookings of fabricated steel in October, 1958 totaled 259,016 tons compared with 255,584 tons in September, 1958; and 181,337 tons in October, 1957; shipments in October, 1958 totaled 307,080 tons compared with 313,701 tons in September, 1958 and 384,797 tons in October, 1957. Backlog of future work as of October 31 totaled $1,912,665 tons.

△ The M. A. Hanna Co. reported for the quarter ended September 30, 1958 net profit was $4,834,333 or $1.57 per share, compared with net profit of $6,181,451 or $2.00 a share for quarter ended September 30, 1957. For the first three quarters of 1958 the net profit was $10,040,280, or $3.25 a share compared with $14,270,931 or $4.62 a share for the same period in 1957.

△ Shipments of iron and steel castings for September, 1958 totaled 1,058,817 short tons compared with 932,611 short tons in September, 1958 and 1,191,598 tons in September, 1957.

November 28

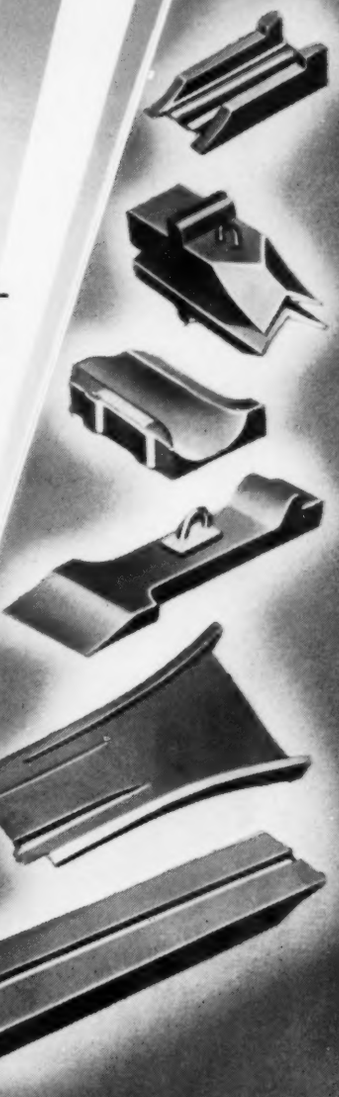
△ Custom smelters reduced price of copper an additional ½¢ to 29¢ a lb.

△ F. W. Dodge Corp. reports that construction contracts in U. S. during October, 1958 totaled $3,309,024,000, 27 per cent over October, 1957.

TRANTINYL GUIDES THE STEEL INDUSTRY

"TRANTINYL" offers a quarter-century of metallurgical experience. "TRANTINYL" patented alloys were developed to function in specific operations where guides are required to resist wear and abrasion. Users of "TRANTINYL" alloys are astounded at the tonnage rolled over one set of guides.

Join the many satisfied users of "TRANTINYL."



ROLLING MILLS:
bar, hoop, strip, shape mill guides; and rollers.

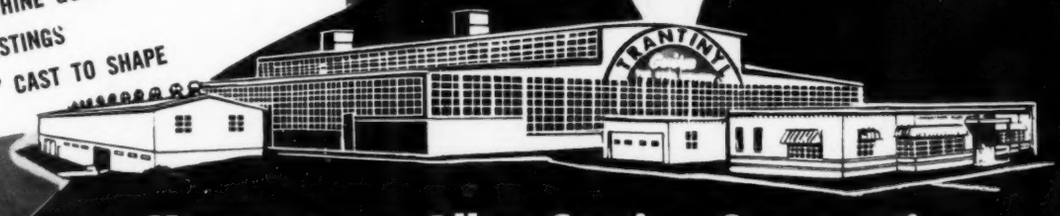
SEAMLESS TUBE MILLS:
guide shoes, rolling mill plugs and rolls, piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing rolls, tool holders, etc.

STRAIGHTENING MACHINE GUIDES

HEAT RESISTING CASTINGS

"TRANTINYL No. 1" CAST TO SHAPE

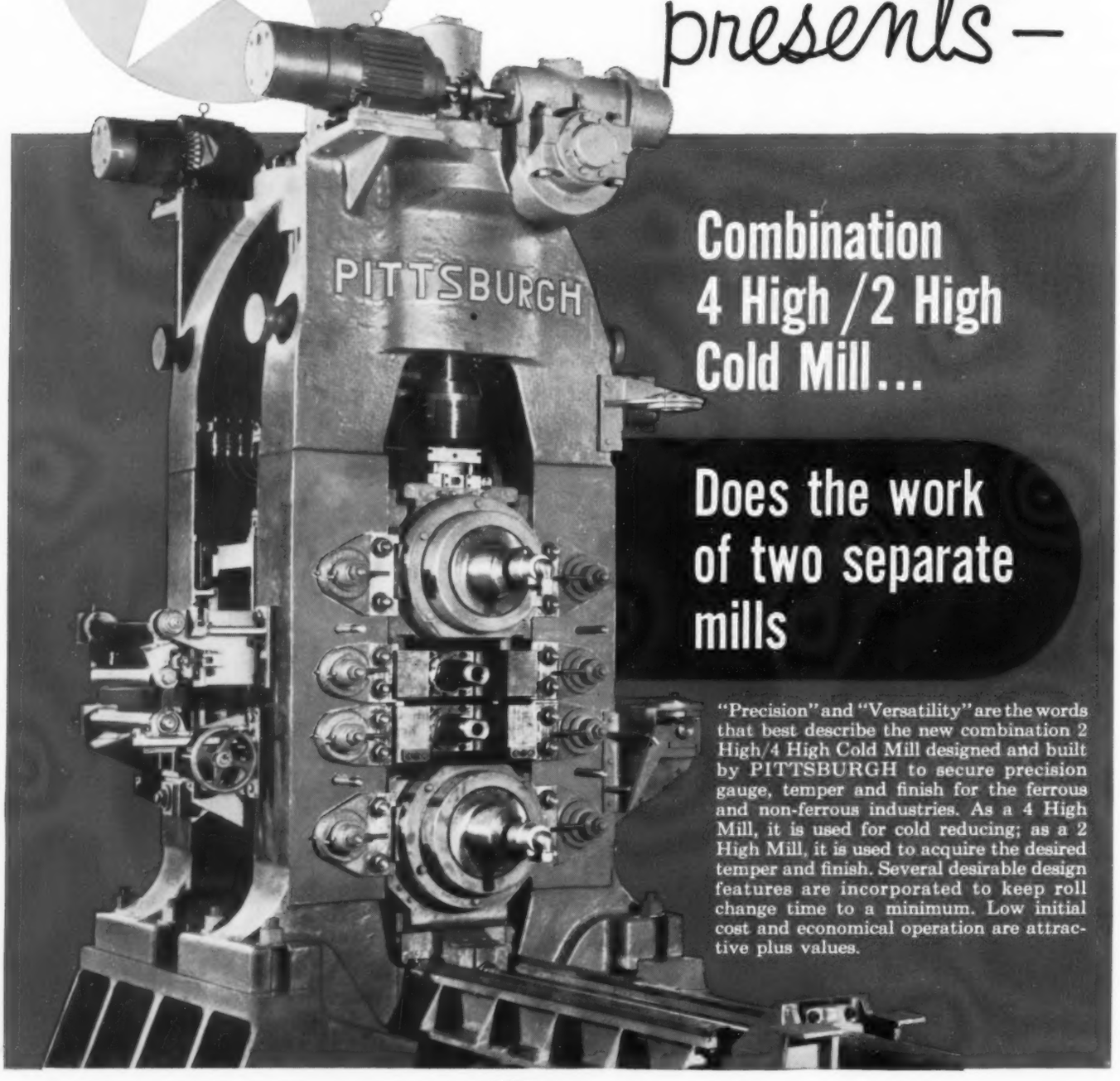


Youngstown Alloy Casting Corporation

Youngstown, Ohio

PITTSBURGH

presents—



Combination 4 High /2 High Cold Mill...

Does the work of two separate mills

"Precision" and "Versatility" are the words that best describe the new combination 2 High/4 High Cold Mill designed and built by PITTSBURGH to secure precision gauge, temper and finish for the ferrous and non-ferrous industries. As a 4 High Mill, it is used for cold reducing; as a 2 High Mill, it is used to acquire the desired temper and finish. Several desirable design features are incorporated to keep roll change time to a minimum. Low initial cost and economical operation are attractive plus values.

Heavy Machining Facilities

Our plant is equipped with a superior complement of well diversified machine tools that are available on a continuing basis for economical machining of heavy castings or the manufacture of auxiliary rolling mill equipment, such as heavy mill tables, furnace pushers, slab depilers, downcoilers, ingot buggies, slab transfers, etc.

PITTSBURGH

ENGINEERING & MACHINE

Division of Pittsburgh Steel Foundry Corporation

P.O. BOX 986, PITTSBURGH 30, PENNSYLVANIA

PLANT AT GLASSPORT, PENNSYLVANIA

Publication Service...

DECEMBER, 1958

(1) Fused Silica Block

A four-page folder describing its new insulating and refractory material, Foamsil, is now available from the Pittsburgh Corning Corp. The folder contains background information on the foamed silica material which is 99 per cent pure fused silica and has a practical operating range of −450 to 2200 F. The material is unaffected by practically all commonly used acids and is unaffected by thermal shock. A list outlining the physical characteristics of the material, along with recommendations for its possible uses, is contained in the folder. Sizes and shapes available are also illustrated. (Booklet FS-1)

(2) Gear Bulletin

Illinois Gear & Machine Co. has issued a brochure on the company's products, plant facilities, quality control facilities as well as information on capacities, types, processes, materials, heat treatments, equipment, etc. (Bulletin 26 IG)

(3) Grid Resistors

General Electric Co. has issued a four-page bulletin describing their new line of mill-duty punched steel grid resistors to meet all a-c and d-c power resistor requirements. The bulletin discusses simplified installation methods and lists key design features including unique grid paralleling, draw-out construction, "clip fastener" and carriage bolt, and all-purpose terminal. Also in the bulletin is information on series and parallel connections, box dimensions and mounting frame dimensions. Charts providing selection and application data are also included. (GEA-6858)

You Can Obtain . . .

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(4) Classifying Systems

The Buell Engineering Co., Inc., offers a bulletin on its new high-efficiency classifying systems. Including two line drawings, two graphs and two installation photographs, the bulletin explains the general operating characteristics of both the centrifugal and gravitational type classifiers. Thirteen advantages of the new systems are listed, including no moving parts, low power requirements and virtually no maintenance. Also given are 16 fields in which the classifiers may be used. Curves illustrate the high efficiencies achieved in actual field installations and indicate particle size distribution of incoming feed, separated fines and coarse material. Additional information is given on operation, arrangement, power requirements, construction, and Buell pilot plant facilities.

(5) Air and Gas Scrubber

The Johnson-March Corp. has published a bulletin on their Type A2 hydro-precipitator scrubber. The bulletin diagrams and describes the equipment's 3-way scrubbing action in the trapping of noncondensable and normal dust-type materials below five microns in size. The bulletin gives specifications for 18 Type A2 scrubber sizes, ranging in capacity from 500 cfm to 40,000 cfm. It also outlines some typical applications where the scrubber has proved efficient up to 99 per cent with 90 per cent of the material below five micron particle size. Design and construction features are explained against a cut-away dimensional drawing, and accessory equipment is listed. (HP 955-A)

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
First Class Permit No. 1963, Sec. 34.9, P.L. & R. Pittsburgh, Pa

IRON & STEEL ENGINEER
1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

IRON & STEEL ENGINEER

Send The *free* Booklets Circled Below:

DECEMBER, 1958

1	2	3	4	5	50	51	52	53	54	55
56	57	58	59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74	75	76	77

NAME _____ TITLE _____

DEPARTMENT _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

* INQUIRIES FOR ITEMS LISTED IN THIS ISSUE NOT VALID AFTER MARCH 1, 1959

PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ADAMS CO., INC., R. P.	BULLETIN 711	Aftercoolers and separators
51	ALLIS-CHALMERS MANUFACTURING CO.		Ideas for modernization
52	ATLAS CAR & MFG. CO.	BULLETIN 1283	Transfer cars
53	BLAW-KNOX CO.	BULLETIN 2564	Refractories
54	BLISS CO., E. W.	CATALOG 40-B	Rolling mills
55	BRISTOL CO., THE	BULLETIN A-130	Pneumatic controllers
56	BUSSMANN MFG. DIV., MCGRAW-EDISON CO.	BULLETIN HCS	Hi-cap fuses
		BULLETIN FIS	Fuses
57	CHEMICAL CONSTRUCTION CORP.	BULLETIN M-103	Washers
58	CLEVELAND TRAMRAIL DIV., CLEVELAND CRANE & ENGINEERING CO.	BOOKLET NO. 2008	Engineering and application data
59	CLEVELAND WORM & GEAR CO., THE	BULLETIN 145	Speed reducers
60	CONE-DRIVE GEARS DIV., MICHIGAN TOOL CO.	BULLETIN CD-218	Speed reducers
61	CROUSE-HINDS CO.		Control of electrical explosion hazards
62	CUTLER-HAMMER, INC.	BULLETIN 505-Y-232	505 mill brakes
63	DURALOY CO., THE	BULLETIN 3354-G	High alloy castings
64	ELECTRIC CONTROLLER & MFG. CO., DIV. OF SQUARE D CO.	BULLETIN 6131	Magnetic control for d-c cranes
65	GENERAL ELECTRIC CO.	BULLETIN GEA-6643	Adjustable-speed drive
66	JOHNS-MANVILLE CO.	BROCHURE IN-115A	Insulating fire brick
67	JOHNS-MANVILLE CO.	BOOKLET PK-126A	Moulded packings
		BOOKLET PK-124A	Asbestos valve stem packings
		BOOKLET PK-35A	Spiral-wound, metal asbestos gaskets
68	LARCO, INC.	BOOKLET AC-573	Crane cab and pulpit air conditioners (Aire-rectifiers)
69	MATTHEWS & CO., JAS. H.		Marking tools
70	POST-GLOVER ELECTRIC CO., THE	BULLETIN NO. 500	Resistors
71	RADIO CORP. OF AMERICA		Industrial television
72	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN NO. D-2506	Packaged drives
73	SPRAYING SYSTEMS CO.	CATALOG 24	Spray nozzles
74	TAYLOR SONS CO., CHAS. THE	BULLETIN 507	Silica cement
75	TAYLOR CHAIN CO., INC., S. G.	BULLETIN 13	Alloy sling chains
76	TAYLOR INSTRUMENT COS.	CATALOG 98262	Potentiometer transmitters
77	WHITING CORP.		Cranes

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 1963, Sec. 34.9, P. L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER
1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

IRON & STEEL ENGINEER

Send The *free* Booklets Circled Below:

DECEMBER, 1958

1	2	3	4	5	50	51	52	53	54	55
56	57	58	59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74	75	76	77

NAME _____ TITLE _____

DEPARTMENT _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

* INQUIRIES FOR ITEMS LISTED IN THIS ISSUE NOT VALID AFTER MARCH 1, 1959

Entry side of 110-in. 4-high reversing hot mill with underdriven edger designed and built by Loewy-Hydropress for Kaiser Aluminum.

New Loewy 4-high slab and plate mill features automatic adjustment of screwdown, edger, sideguards

Designed for high productivity, automated operation, low maintenance cost, and minimum downtime, this new 110-in. 4-high universal slab and plate mill reaffirms Loewy-Hydropress' position of leadership in forming metal. Programmed punch card operation controls the adjustment of screwdown, edger and sideguards in any required preselected sequence, thus relieving the operator of the many split-second decisions usually required. The edger is an underdriven, close-coupled, vertical unit. Rolls are readily removable without disassembly of spindles or any other associated equipment. Horizontal rolls are easily changed by a motor-driven roll changing sled.

Loewy has also built other mills and auxiliary machinery for the same plant.

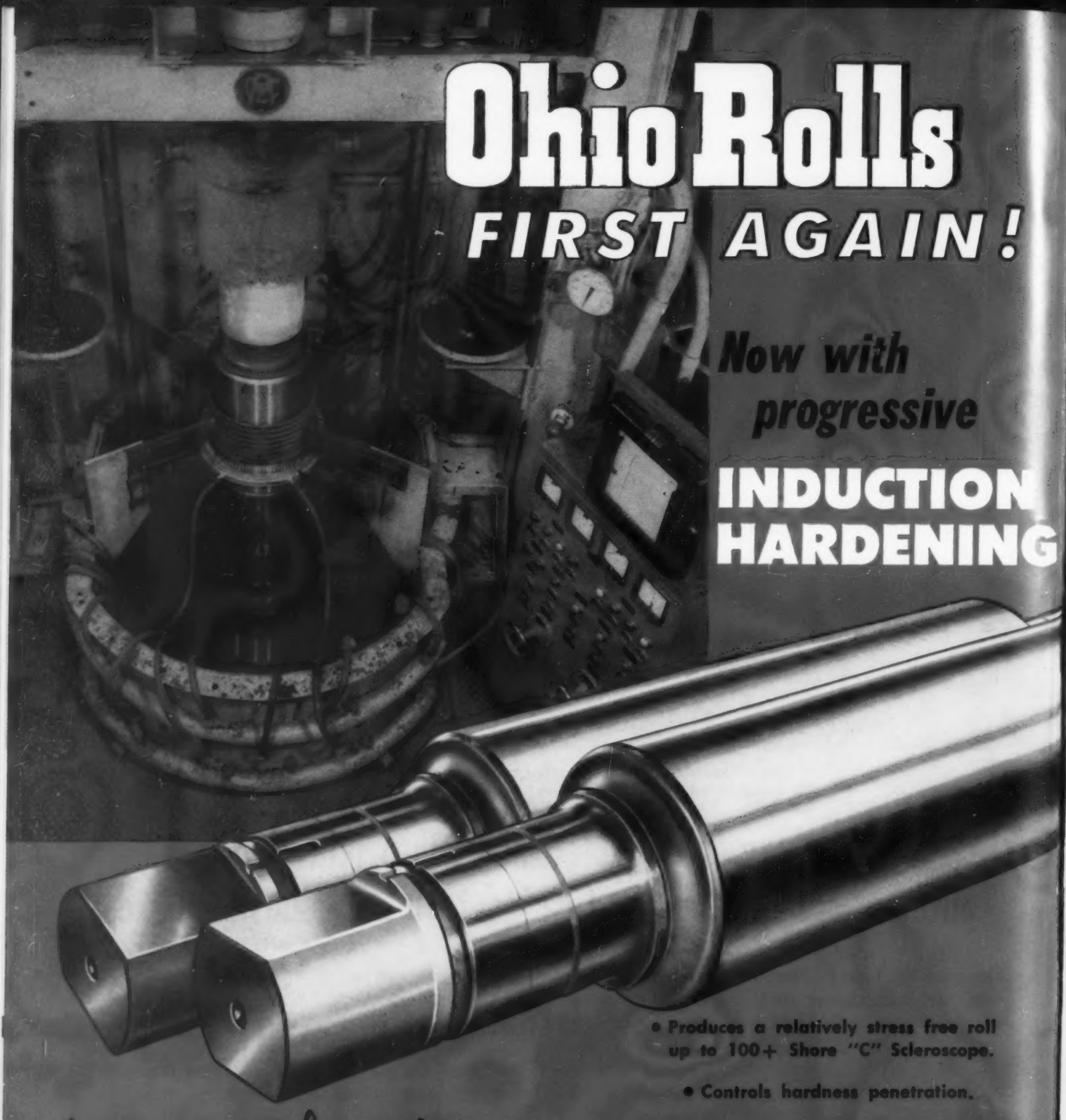
Loewy designs and builds special machinery to the most exacting demands, modernizes and rebuilds existing installations, supplies completely equipped new plants. And with the vast facilities of the entire Baldwin-Lima-Hamilton organization at our disposal we can complete your job on time . . . very likely even ahead of schedule. For further information, write us at Dept. C-12.

Loewy-Hydropress Division

BALDWIN · LIMA · HAMILTON

111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

BALDWIN BLH LIMA-HAMILTON



Ohio Rolls
FIRST AGAIN!

Now with progressive

INDUCTION HARDENING

- Produces a relatively stress free roll up to 100+ Shore "C" Scleroscope.
- Controls hardness penetration.
- Offers superior roll performance.
- Tested and proved by nearly 3 years' actual experience.

shaping metal for all Industry

THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO

Plants at Lima and Springfield, Ohio

LIMA... Virtually at the center of the steel industry

OR23

Ohio Iron and Steel Rolls: Carbon Steel Rolls—Ohioloy Rolls—Ohioloy "K" Rolls—Flintuff Rolls—Double-Pour Rolls—Chilled Iron Rolls—Dense Iron Rolls—Nickel Grain Rolls—Nioloy Rolls—Special Iron Rolls—Forged Steel Rolls

Industry News...

TWO YEAR IMPROVEMENT PROGRAM SCHEDULED FOR HOT STRIP MILL AT CAMPBELL WORKS

△ The Youngstown Sheet and Tube Co. has announced a two-year program to revamp the 79-in. hot strip mill at its Campbell plant. This is another step in the company's improvement program which has been in progress in the Youngstown district for several years. Two downcoilers, to handle larger coils from the revamped hot strip mill, were installed in 1956. At the same time major producing units of the cold strip mill were revamped to handle larger coils.

The improvement, which will cost in excess of $50,000,000, will enable the mill to roll larger diameter coils—up to 40,000 lb—of higher quality than now is possible.

In the cold strip mill, temper mills and the pickling lines are being altered for the larger diameter coils, and new shearing capacity is being installed. Minor alterations will be made to the Campbell and Brier Hill blooming mills as part of the hot strip project.

The Bessemer converter plant, abandoned in October and its nearby blowing engine house are being torn down. The present iron foundry, pig casting machine, ladle house and buildings housing the rigger shop, tin shop, property protection department, electric repair shop and pattern shop will be dismantled and relocated.

Five new buildings, with 210,000 sq ft of floor space will be erected. These will be:

New slab yard building 716 ft long, 110 ft wide and 69 ft high, equipped with two 80-ton cranes.

New roll and bearing shop, 716 ft long, 40 ft wide and 40 ft high, equipped with one 100-ton crane.

Mill building extension, 630 ft long, 84 ft wide and 54 ft high, equipped with a new 100-ton crane.

Motor room extension, 420 ft long, 54 ft wide and 40 ft high, equipped with a new 35-ton crane.

Slab yard extension, 420 ft long, 55 ft wide and 42 ft high.

The mill's width of 79 in. will not be changed. Three new slab heating furnaces, the world's largest used on hot strip mills to date, will be installed along with a new roughing section and a new crop shear. New power units will be installed on the present finishing section.

The new slab heating furnaces, each 28 x 100 ft, will incorporate five zones of heating control to assure quality heating. Maximum slab sizes will be 26 ft long and 9½ in. thick compared with the present maximum of 16½ ft long and 4¾ in. thick.

The roughing section will employ a six-stand roughing train compared with four stands at present. The new mills will consist of a vertical edging scale breaker, a 42 x 54 x 136-in. broadside mill and two 42 x 54 x 79-in. universal roughing mills. Three existing universal roughing mills will be used.

The roughing section will have the largest total connected horsepower (33,000 hp) of any roughing mill in the United States.

Rolling speed of the present finishing section will be increased from 1400 to 2250 fpm. Latest automatic electronic equipment will be installed to assure gage and width control.

Like the roughing section, the finishing section, with 35,500 hp, will have the largest total horsepower (main drive) capacity of any finishing section in the steel industry.

Coil transfer equipment will be installed to convey the larger coils from the present downcoilers to the coil storage yard.

CONVERTS CONTINUOUS MILL TO ROLL BEAMS

△ Birdsboro Steel Foundry & Machine Co. recently completed modification of existing roll stands in a continuous mill to permit the rolling of universal beams. The conversion, at Northwestern Steel and Wire Co., Sterling, Ill., is the first installation where wide flange beams are rolled on a continuous mill.

The new universal stands were rebuilt from existing horizontal, two-high stands. This conversion enabled Northwestern to enter the wide flange beam business at a fraction of the cost and in a fraction of the time required for a new mill.

Birdsboro completed the changeover of the mill in only five months,

RELIANCE LAUNCHES MOBILE DISPLAY

This giant mobile display was launched this month by Reliance Electric and Engineering Co. on a year-and-a-half tour of the United States. The display, called the "R-Cade," is housed in a specially built 32-ft trailer. The R-Cade will visit plants across the country to show businessmen, engineers and industrial production supervisors a variety of Reliance motors and drive products in operation. Within the walnut-paneled interior of the trailer, visitors will see displayed a-c and d-c motors, variable-voltage drives, mechanical variable-speed drive systems, gearmotors, motor control units and a demonstration of process control. The purpose is to help engineers, purchasing agents and production men better visualize the potential application of this type of equipment.

20-FOOT FURNACE ROLLS
Centrifugally Cast

. . . of Duraloy HH Alloy, one of the most widely used high chrome, medium nickel alloys.

Two items concerning these furnace rolls may be of particular interest:

a—the size: 20 feet long—14" OD, ¾" wall thickness

b—*welding operations* by which reducing cones and shafts (both statically cast of the same alloy) were welded to the centrifugally cast rolls

These two items will serve to emphasize two phases of our service: (1) the large size centrifugally cast tubes we are able to produce and (2) our machining and finishing facilities, including welding.

Our new 16-page general Bulletin — 3354-G — gives complete details. Would you like a copy? When writing or calling would you mind telling us the general nature of your high alloy casting requirements? Better yet, if you have specific requirements on which we could help, let us have the details.

The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich

DURASPUN

adding all new rolls to the stands. Several existing horizontal stands were converted to take vertical rolls. Completely new shapes were required for the horizontal rolls. The converted mill can be used to produce other carbon steel forms such as angles, channels and plate by switching stands.

BEGINS CONSTRUCTION OF NEW COKE OVENS

△ Construction of a new battery of by-product coke ovens is under way at Jones & Laughlin Steel Corp.'s Pittsburgh Works.

The new battery will consist of 59 Wilputte ovens with a rated monthly capacity of approximately 30,000 tons of coke. The battery is being constructed on the site of an older 60-oven battery which was deactivated in 1953. Construction should be completed in the fall of 1959.

J&L currently operates six by-product coke batteries with a total of 379 ovens at the Pittsburgh Works. These ovens have a rated monthly capacity of approximately 100,000 tons of coke.

The installation also includes additional coal bin capacity and a new quenching station.

The new battery will feature the Wilputte rotating table charging car which permits rapid chargings without smoke emersion. Coal for the ovens will be charged mechanically rather than by gravity for a more uniform distribution in the oven.

The installation also will include the Wilputte pusher machine which has a one-position stop for door removal and coke pushing. In older-type pusher machines, it was necessary to change position several times for these operations.

REPUBLIC TO ADD NEW GADSDEN PLATE MILL

△ Republic Steel Corp. announced plans to install a new plate mill at its Gadsden, Ala., plant.

Work on the new four-high, 112-in. reversing hot rolling mill will get under way after the first of the year.

This mill will replace the present three-high, 112-in. mill and will be installed on a new foundation 64

ft closer to the hot strip mill to permit more efficient operation.

Skelp for pipe ranging from 24 to 30 in. in diam made at the plant, will be rolled from slabs weighing up to 8000 lb, which is double the weight of the slabs rolled for this purpose on the old mill.

Also to be rolled for finishing on the plant's 54-in. hot strip mill are slabs weighing up to 13,000 lb, which is almost twice as heavy as the slabs previously processed for the strip mill. Ultimately, the mill will be capable of rolling slabs up to 20,000 lb as new equipment is added.

In addition to the skelp and slabs for in-plant use, the new mill may produce some plate tonnage for the trade.

The present mill will remain in operation until shortly before the new mill is ready to be placed in production. Only about 10 to 14 days of production time will be lost to permit the old mill to be dismantled while final touches are applied to the new mill.

A set of vertical edgers will be installed approximately 13 ft from the entry side of the mill. The edgers help obtain closely controlled widths and provide minimum loss from side trim on skelp and strip. Twin electrical drive motors, each with a 5000 hp rating, will provide power for the mill.

A major part of the steel processed at Gadsden goes through the plate mill since the pipe mill and strip mill which it serves are the two heaviest tonnage users among the several finishing mills at the plant.

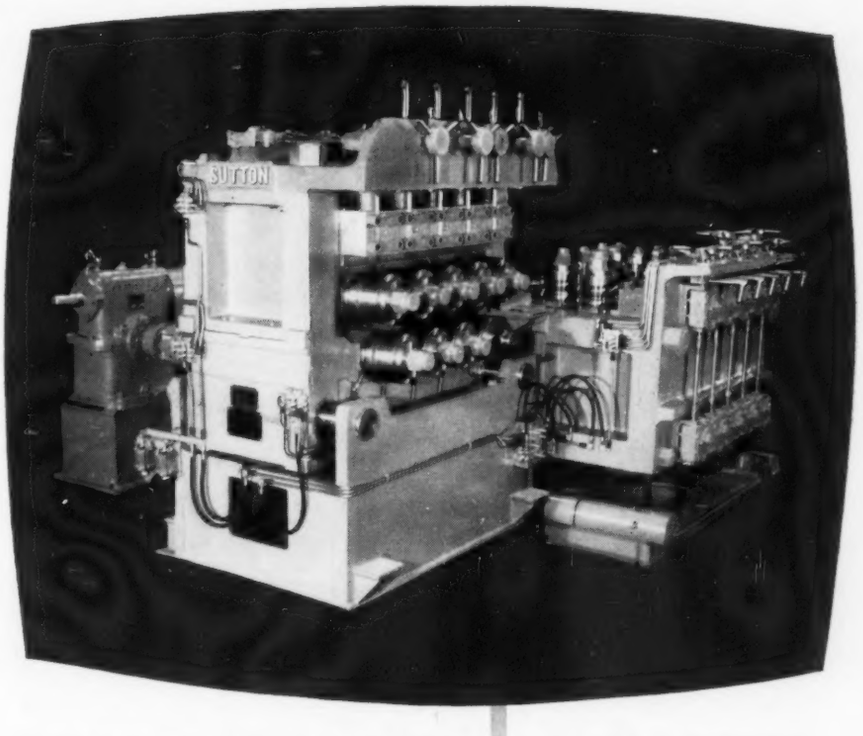
BIRDSBORO GIVEN TUBE MILL ORDER BY TIMKEN

△ Birdsboro Steel Foundry and Machine Co. has received an order from Timken Roller Bearing Co. for a tube piercing mill, including accessory equipment, for piercing alloy and stainless steel tubing.

The complete piercing mill with inlet and outlet tables is scheduled for delivery to Timken's Gambrinus Works in June, 1959.

G. Clymer Brooke, president of Birdsboro said this is the first piercing mill ever built by his company and represents the start of a complete line of seamless tube mill equipment to be offered for the

HIGH-SPEED TWO-PLANE SHAPE STRAIGHTENER



Accurately straightens flats and shapes of all metals at high production speeds

Here is a superior, new Sutton machine for vertical and horizontal two-plane straightening of steel and non-ferrous flats and shapes including squares, hexagons, angles and other similar sections.

Featured are large roll shafts on close centers. This permits removal of short hooks, waves and kinks. No intermediate guide rolls are needed. Anti-friction bearings are used throughout; unitized shaft construction permits rapid removal. Alignment of roll passes is accomplished quickly.

SUTTON 2-L STRAIGHTENER
(Pictured)

For Squares
from ¼" to 1½"

For Hexagons
for ¼" to 1¾"

For Flats
up to 2½" x ½"

Available in all sizes for two-plane or single-plane vertical or horizontal use.

Ask for complete data

SUTTON *Engineering Company*
FIRST NATIONAL BANK BLDG., PITTSBURGH 22, PA.
PHONE: GRANT 1-8077 • PLANT: BELLEFONTE, PA.

Manufacturers of Straighteners, Hydraulic Extrusion Presses, Centerless Bar Turners, Rotary Swagers, Sheet Levellers and other Processing Machines for Modern Metals.

manufacture of ferrous and nonferrous products.

Birdsboro will design and build to customer specifications any size or design tube mill equipment including: piercers, plug mills, elongators, reelers, sizing mills, stretch reducing mills, mandrel mills, tube straighteners, hydrostatic tube testers, and related handling equipment. Mr. Brooke also announced that Birdsboro will make a complete line of welded tube mill equipment.

OPEN HEARTH CONTRACT AWARDED TO LOFTUS

△ Loftus Engineering Corp. has been awarded a contract to provide all engineering and construction supervision for the entire open hearth portion of Argentina's new steel mill, Sociedad Mixta Metalurgia Argentina (Somisa).

The contract was awarded by the government of Argentina on approval of Armco International Corp., acting as consultant on the project. The completely integrated mill, located at San Nicholas, is scheduled for completion by July, 1961, and will have an annual capacity of 750,000 metric tons. The Export-Import Bank is aiding the government of Argentina in this $475,000,000 project.

The new steel mill will contain four 250 metric ton open hearth furnaces, stock house, stripper calcining plant, scrap drop, mould yard, and other buildings, trestles and runways.

◀ Blast furnace linings
◀ Blast furnace run-out troughs
◀ Cupola linings
◀ Steel pickling tanks

Standard sizes and shapes • Tested performances
Competent technical service • Superior chemical and metallurgical characteristics • Graphite brick also available.

May we give you a quotation?

ELECTRODE GLC® DIVISION

GREAT LAKES CARBON CORPORATION

18 EAST 48TH STREET, NEW YORK 17, N.Y. • OFFICES IN PRINCIPAL CITIES

J&L ADDS NEW SINTER PLANT AT ALIQUIPPA

△ Jones & Laughlin Steel Corp. announced the start of construction on a new ore sintering plant and ore screening facilities at its Aliquippa, Pa., Works.

The new unit, which will more than triple the production of blast furnace sinter at the Aliquippa Works, will improve and increase blast furnace performance by approximately 20 per cent. Upon completion of the new facilities in 1960, the daily rated capacity of the five blast furnaces at Aliquippa will be about 7200 tons of pig iron, according to Paul H. Devaney, J&L's Aliquippa Works Manager.

Dravo Corp. has been awarded the contract for the installation of the new facilities.

The sintering machine itself is a Lurgi traveling grate type with a traveling bed of material 13 ft-2 in. wide and 184 ft long. The material may be 12 to 16 in. deep.

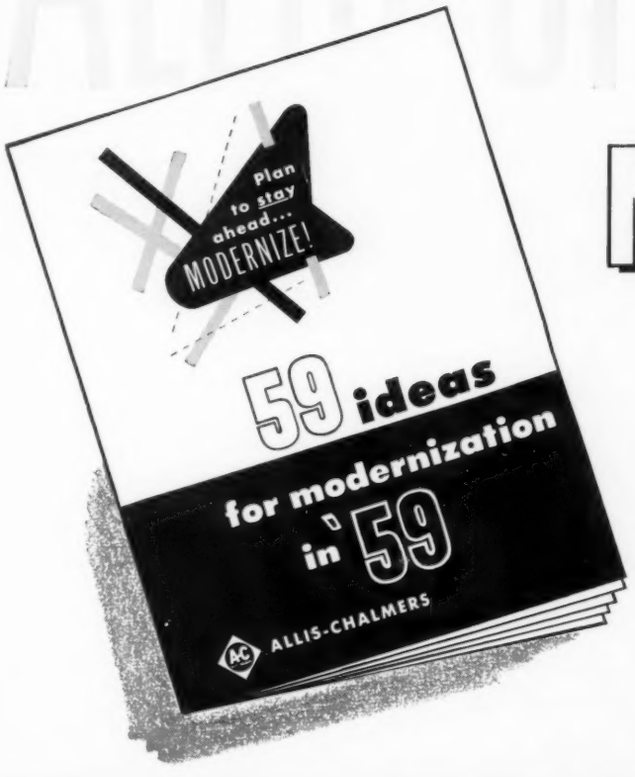
The new Aliquippa plant will have a daily production capacity of 6500 net tons of self-fluxing blast furnace sintered ore charge. This unit will replace four narrow sintering strands which average approximately 1800 tons of sinter daily.

Meetings

△ The Fifth National Symposium on Reliability and Quality Control will be held January 12–14, 1959, at the Bellevue-Stratford Hotel, Philadelphia, Pa.

△ The Tenth Plant Maintenance & Engineering Conference will be held during the first three days of the Plant Maintenance & Engineering Show at the Public Auditorium, Cleveland, Ohio, January 26–29, 1959.

Plan to stay ahead... MODERNIZE!

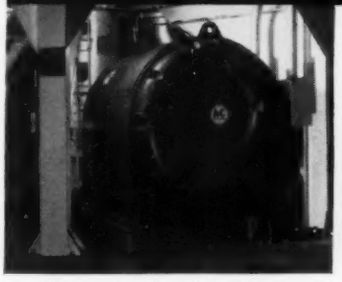


NEW brochure of ideas for modernizing

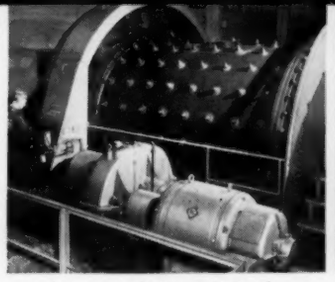
This booklet is based on the premise that modernization can start anywhere in your plant. It can be a single machine or operation . . . a better way of getting variable speed . . . a faster way to braze . . . or a newly available replacement. In fact, this type of updating is far more common than the sweeping change.

Get a copy of "59 ideas for modernization in '59" from your nearby A-C office or write Allis-Chalmers, Industries Group, Milwaukee 1, Wisconsin.

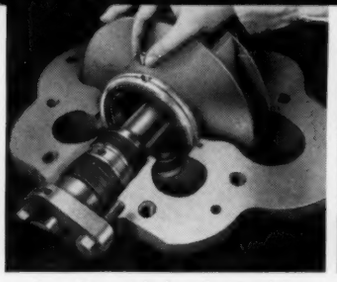
Typical examples of updating ideas!



New motor development may eliminate premiums you've been paying for specially protected motors.



Using one grinding mill in place of two can improve product quality as well as saving space and labor.

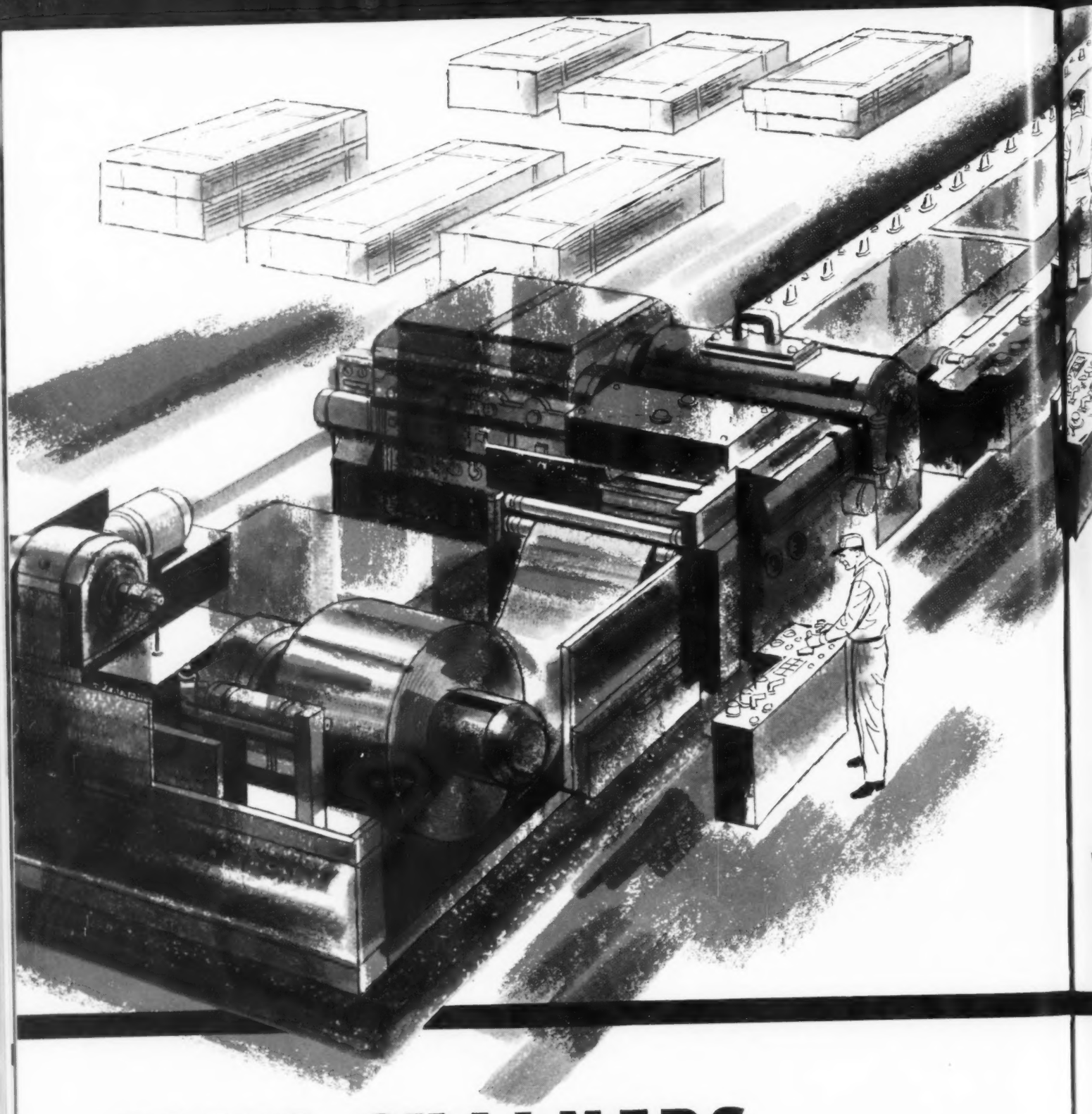


Jamming and clogging in double-suction pumps can be eliminated by pumps with adjustable wearing rings.

Electrical modernization includes placing substations close to machines being served. Roof or basement is often the answer.

A-C ALLIS-CHALMERS

A-5851



ALLIS-CHALMERS

CONTROL...

from furnace to finish

Plan to stay ahead... MODERNIZE!

Advanced, Coordinated Control for your Shearing Line

SHEARING LINE CONTROL — Here's advanced, dependable control for fast, smooth acceleration and deceleration. You get complete synchronization from reel to piler with finger-tip response. Variable voltage control featuring magnetic amplifiers and constant potential control are integrated with ac and dc motors into a smoothly functioning system.

Regardless of your needs, you can get control equipment from Allis-Chalmers designed to meet your specific application. Allis-Chalmers builds control not only for rough, tough furnace and main mill applications, but control to provide the precise coordination required for processing lines and also equipment for accurate regulation and exacting performance of finishing mills.

Special study is given to each application so that control components are properly integrated to provide maximum output with minimum downtime. In addition, Allis-Chalmers has the specialized knowledge to coordinate control throughout your entire mill.

If you want to learn more about control designed to meet your specific mill requirements, call your nearest A-C representative or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-5513

from Blaw-Knox . . .

BeeKay refractory products include silica and high alumina brick, super duty, first quality and intermediate quality fire brick, plastic fire brick, Missouri quality products, cements and mortars, and castable products.

the BeeKay refractory line

The list of Blaw-Knox products and services for the metals industry has grown steadily since the company's founding. Now Blaw-Knox adds the complete line of BeeKay refractories to better serve this industry.

The BeeKay product-service combination adds up to a program of supply designed to cut costs through the use of refractory materials specifically matched to job requirements.

BeeKay materials are top quality. Clay earths as well as all additive materials are processed by the most modern methods and machinery. Constant quality control is exercised both in process and in a fully equipped laboratory.

Finally BeeKay service. Since Blaw-Knox is a constant user of refractories in its own furnaces, the company has a customer's understanding of transportation, delivery and inventory problems. Your BeeKay refractory man will be glad to assist you in the selection of the proper refractory for your operation as well as providing the service to assure efficient, economical inventories. For complete details, write for a copy of Bulletin 2564.

BLAW-KNOX

BLAW-KNOX COMPANY

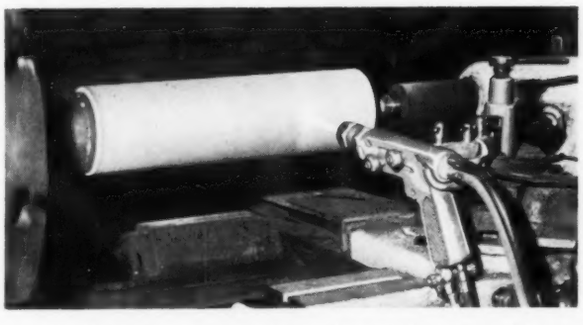
300 Sixth Avenue

Pittsburgh 22, Pennsylvania

SPRAYWELD® Hard Surfacing Cuts Journal Costs

Table roller journal sleeve maintenance costs were cut from $21.06 to only $1.50 each per month through the use of the Colmonoy Sprayweld (reports the September 1957 issue of *Iron and Steel Engineer*). The Sprayweld, a universally accepted powder metal spraying unit, applies Colmonoy hard-surfacing alloys to provide low-cost protection against abrasion, impact, heat, and corrosion.

The Colmonoy Sprayweld sprays powdered Colmonoy alloys to form smooth, even overlays. The overlays are then fused to the part, forming an integral surface of wear-resistant alloy. Write now for complete information about this versatile maintenance tool.



Journal sleeves are made of low carbon seamless steel tubing, with an overlay of Colmonoy No. 6 hard-surfacing alloy, applied by the Sprayweld. The sleeve is rotated in a lathe, with the Sprayweld mounted in a tool-post holder.

HARD-SURFACING AND BRAZING ALLOYS

WALL COLMONOY CORPORATION

19345 John R Street • Detroit 3, Michigan

BIRMINGHAM · BUFFALO · CHICAGO · HOUSTON · LOS ANGELES
MORRISVILLE, PA. · NEW YORK · PITTSBURGH · MONTREAL · GREAT BRITAIN

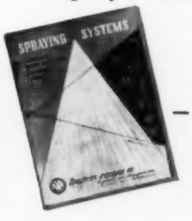
every installation a complete success

with Spraying Systems Co.

Spray Nozzles

for hot strip spray cooling descaling roll cooling and related operations

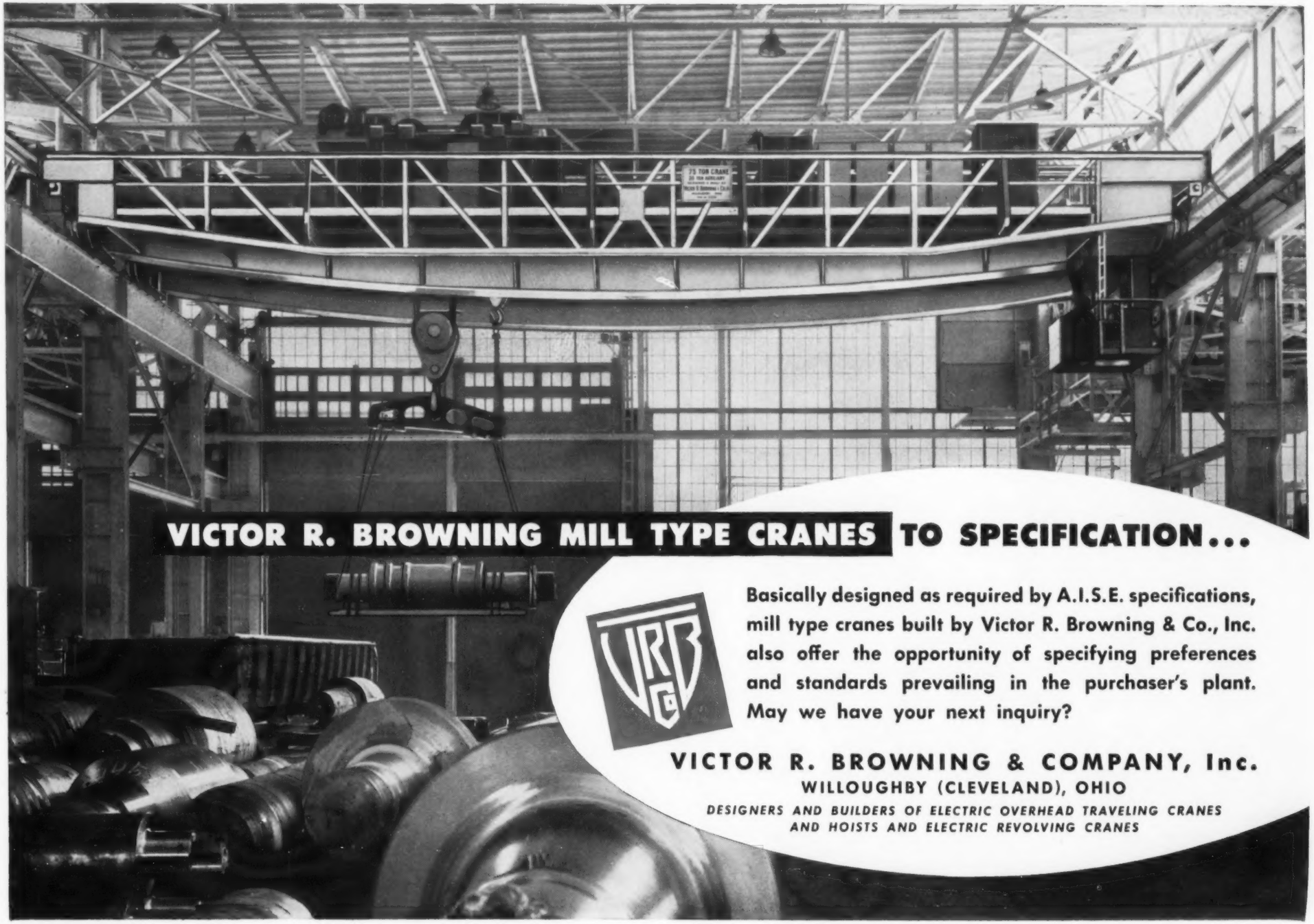
● Greater spraying efficiency and lower equipment and maintenance costs are the advantages Spraying Systems Co. spray nozzles give you. Nozzles for hot strip cooling for example, give better steam barrier penetration and spray distribution . . . remove more heat per minute per gallon of water. Descaling nozzles provide greater impact for any volume and pressure without excessive cooling. Non-clogging design and recommended types of mounting are features that help reduce maintenance costs. Your inquiry is cordially invited for Spraying Systems Co. spray nozzle data and application information.



SPRAYING SYSTEMS CO.

3262 RANDOLPH STREET • BELLWOOD, ILLINOIS

For information on Spray Nozzles and Steel Mill Applications write for Catalog 24 and Supplementary Data Sheets.



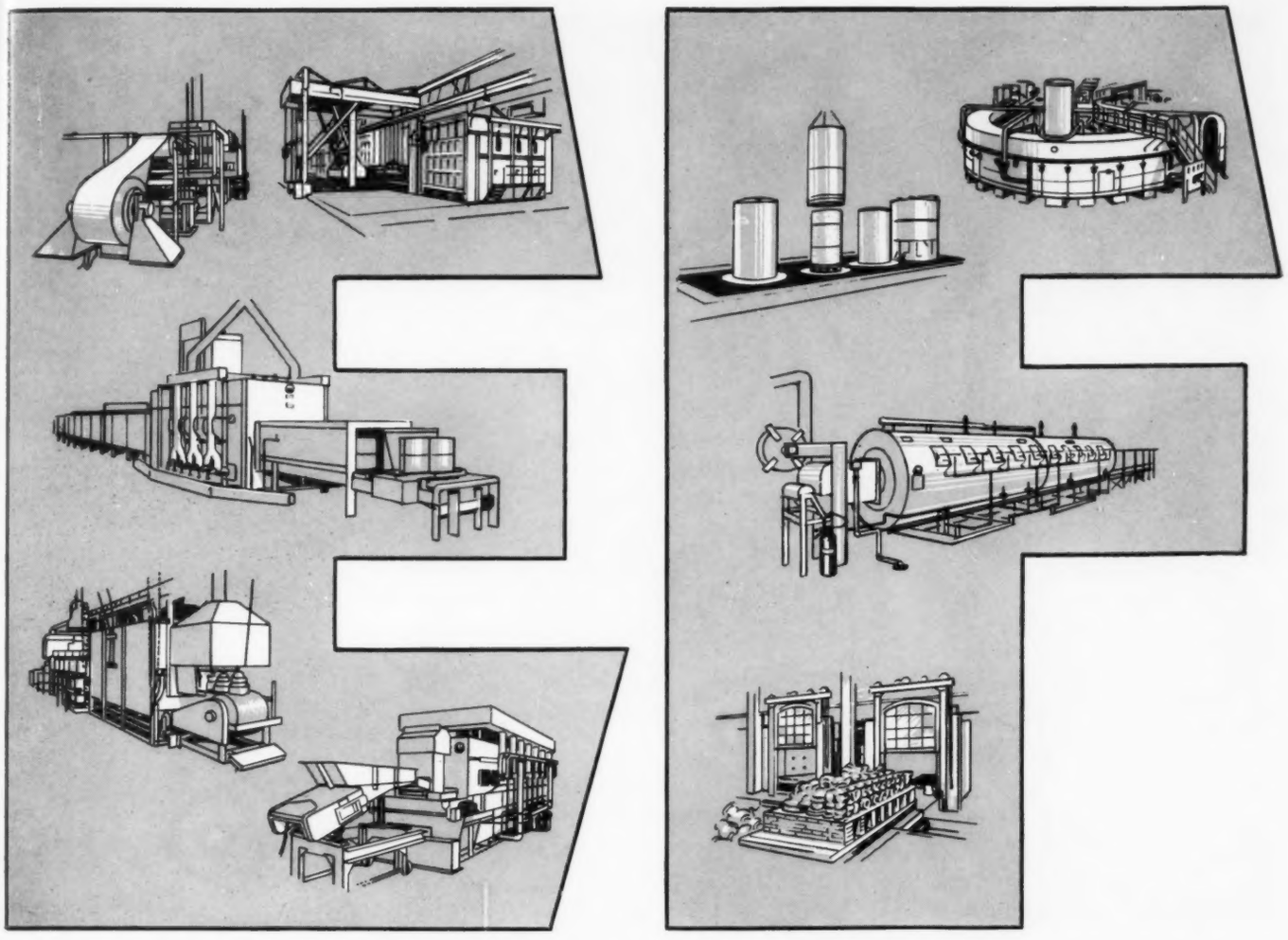
VICTOR R. BROWNING MILL TYPE CRANES TO SPECIFICATION...

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.

WILLOUGHBY (CLEVELAND), OHIO

DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES



Large capacity EF gas fired furnace bright annealing stainless strip. We build them electrically heated or gas fired for wide or narrow strip, for single or multiple strands.

Part of an installation of large EF gas fired three-stack rectangular bell type forced circulation special atmosphere furnaces for annealing steel strip.

EF BUILDS THE TYPE YOU WANT in the size you need-

no job is too large or too unusual

We have the engineers, the experience, the research and experimental departments and the complete manufacturing and erection facilities to build any size or type of furnace required to handle any heat treating process.

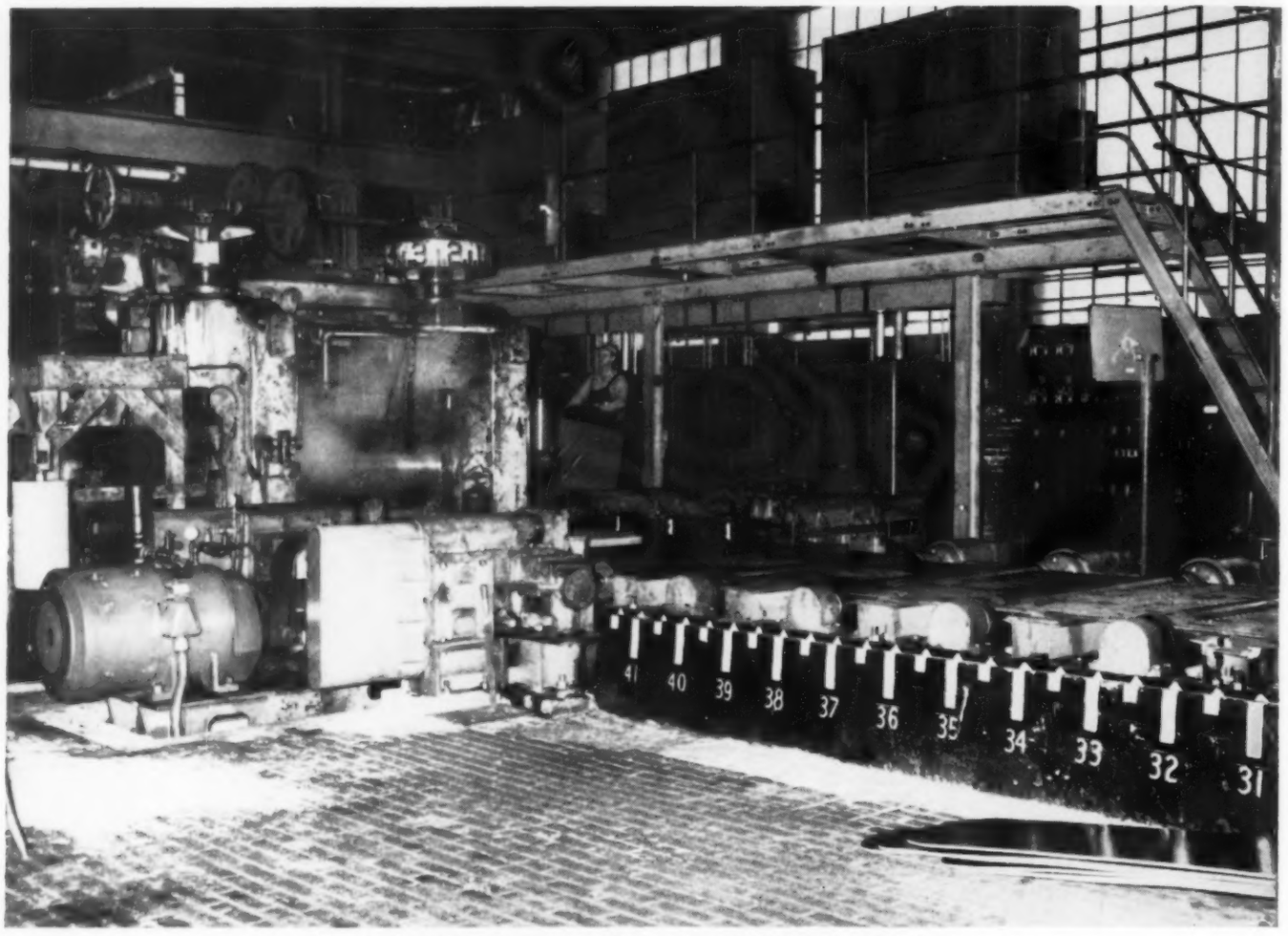
Submit your production furnace problems to experienced engineers—it pays

THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

Salem - Ohio

Canadian Associates • Canefco Limited • Toronto 13, Canada



Packaged M-G sets and controls are located right at the hot mill in Revere Copper and Brass, Incorporated's New Bedford, Mass. plant

Reliance Packaged Drives cut Modernization Cost 20%

Instead of one large motor-generator set, Revere Copper and Brass, Incorporated used five packaged V★S Drives to power the edger and tables on their rebuilt hot mill.

Reliance Drives package the M-G sets with controls and put them right at the mill itself. Conduit runs are of minimum length, which reduced not only material costs but construction time.

Control installation was vastly simplified. Each V★S Unit was prewired and pretested before shipping. The complete V★S Cabinets had only to be set in place and connected. Extra construction was not required for a generator room.

Packaged V★S Drives cut costs for Revere and gave more flexibility of operation and greater ease of maintenance. Reliance Packaged Drives will reduce drive installation and operating costs for any type of mill.

For complete details contact your Reliance representative, or write today for Bulletin No. D-2506. L-1586

MASTER REEVES R **RELIANCE** ELECTRIC AND ENGINEERING CO.

DEPT. 1112A CLEVELAND 17, OHIO
CANADIAN DIVISION: TORONTO, ONTARIO
Sales Offices and Distributors in Principal Cities

CUT RED TAPE
...and...
CUT YOUR COSTS

Like so many others, you too can definitely save time...cut red tape...and ...also cut your costs--by using Berry's inventory as *your* inventory.

By so doing you can then safely minimize your inventory...decrease your investment...save on storage space...eliminate handling...reduce record keeping...and...lower your insurance and taxes proportionately.

With a regular inventory of over 50,000 types and sizes of bearings, bearing specialties, and transmission appliances--Berry can supply you with anything and everything you need. And, you can depend on *immediate delivery* on every order, large or small.

To cut red tape...and...cut your costs--phone bearing headquarters--NOW.

MEMBER AFBDA ANTI-FRICTION BEARING DISTRIBUTORS ASSOCIATION

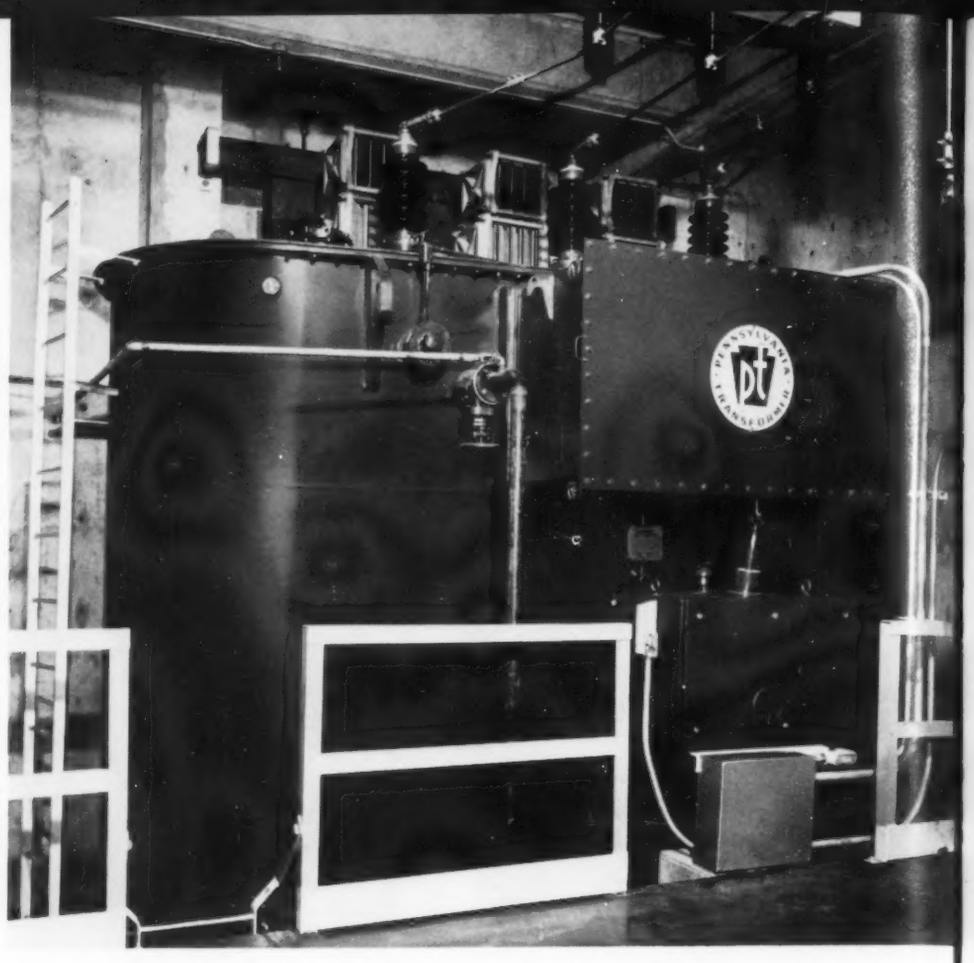
BERRY BEARING COMPANY

All phones--DAnube 6-6800

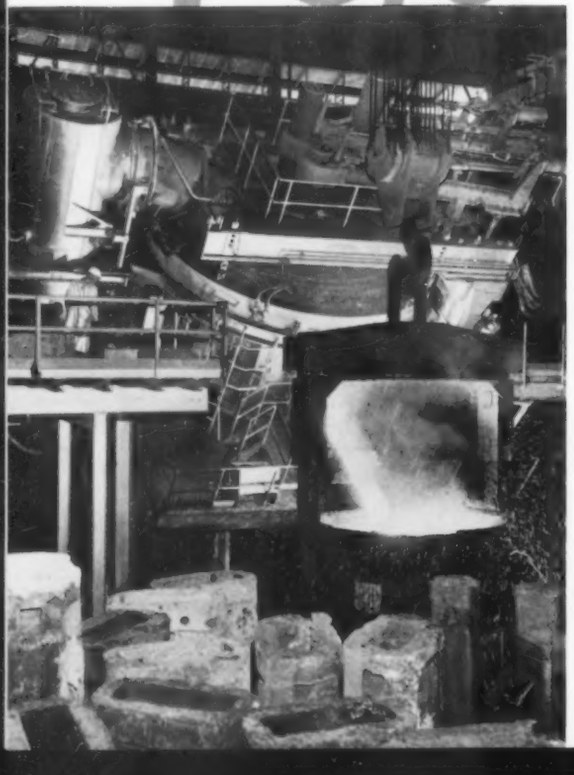
2633 S. Michigan Ave. • • • • Chicago 16, Illinois

SOUTHWEST	OAK PARK	SKOKIE	ROCKFORD	HAMMOND	GARY	JOLIET
6923 W. Archer Ave.	327 Madison St.	4438 Oakton St.	710 Broadway	4828 Calumet Ave.	716 E. 5th Ave.	568 N. Chicago St.
LUdlow 5-4400	EUclid 6-1700	ORchard 4-6600	Phone: 2-5561	WEstmore 1-3010	TUrner 5-7501	JOliet 3-3446

Pennsylvania Furnace Transformers help BOOST INGOT CAPACITY 70%



One of two such units at a leading West Coast steel plant, this 25,000-kva Pennsylvania Furnace Transformer is helping set new production records at lower cost per ton. The transformers supply power to two 100-ton Lectromelt Furnaces—also products of McGraw-Edison Company.



Two 25,000 Kva Transformers Team up with Lectromelt Furnaces in Replacement of Open Hearths

Replacement of gas-fired and oil-fired open hearths by two 100-ton Lectromelt Furnaces has increased the annual capacity of a leading West Coast steel mill from 246,000 to an estimated 420,000 ingot tons per year . . . while costs per ton have been substantially lowered.

A dependable, efficient source of power is of prime importance in the establishment of such a record. Two 25,000-kva Pennsylvania Furnace Transformers are meeting the challenge—converting the 34,500 volts supplied by the utility to low voltages that range from 450 to 300 volts. The maximum line current is 37,100 amperes.

Pennsylvania Furnace Transformers can withstand the repeated short circuits and heavy overloads that are characteristic of such service because of design and construction features that have stood the test of decades. These include electrically balanced, precompressed coils . . . extra sturdy bracing of coils and bus bars . . . and a coil design in which individual conductors are transposed to reduce copper eddy losses.

To reduce down time during periodic inspections, the motor-driven tap changer is housed in separate compartments that are isolated from the main tank. The tap changer has a provision for emergency hand operation.

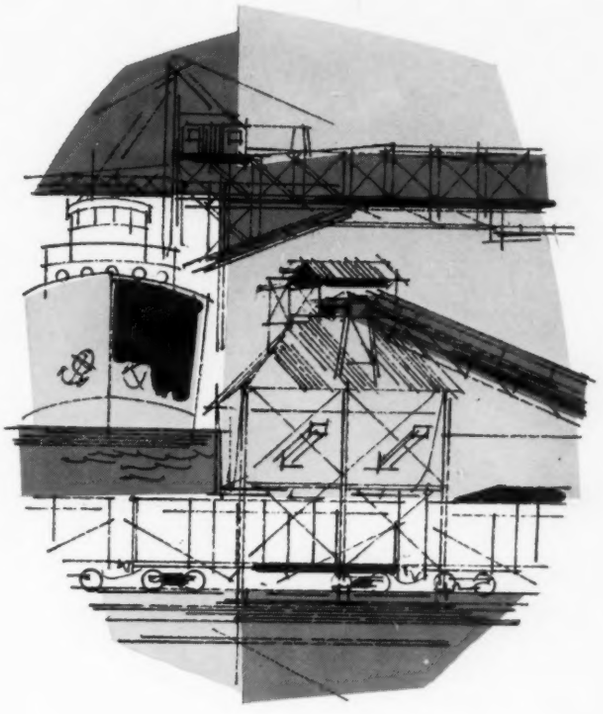
To take advantage of Pennsylvania's unsurpassed know-how and record in the design and manufacture of furnace transformers, contact Pennsylvania Transformer Division, McGraw-Edison Company, Box 330, Canonsburg, Pa.

McGRAW EDISON

Pennsylvania Furnace Transformers

PENNSYLVANIA TRANSFORMERS

MATERIAL HANDLING ENGINEERING WITH A *Creative Twist*



An unloading, hoisting, storage, and distribution plant for an open hearth mill in a midwestern steel plant.

Finding the right solution to a difficult material handling problem is a design and engineering job—but with a creative twist. It requires the ability of the engineer to combine his creative imagination with seasoned experience and technical skill.

Roberts & Schaefer engineers will do the job. They have a reputation for creative thinking, for practical engineering, for sound construction performance. That's why R&S is called in on so many complex jobs—jobs for old customers who got exactly what they wanted the first time.

We would like to talk with you about our comprehensive facilities for design, engineering and construction of material handling plants complete with all necessary processing, distributing and storage systems.

ENGINEERS & CONTRACTORS

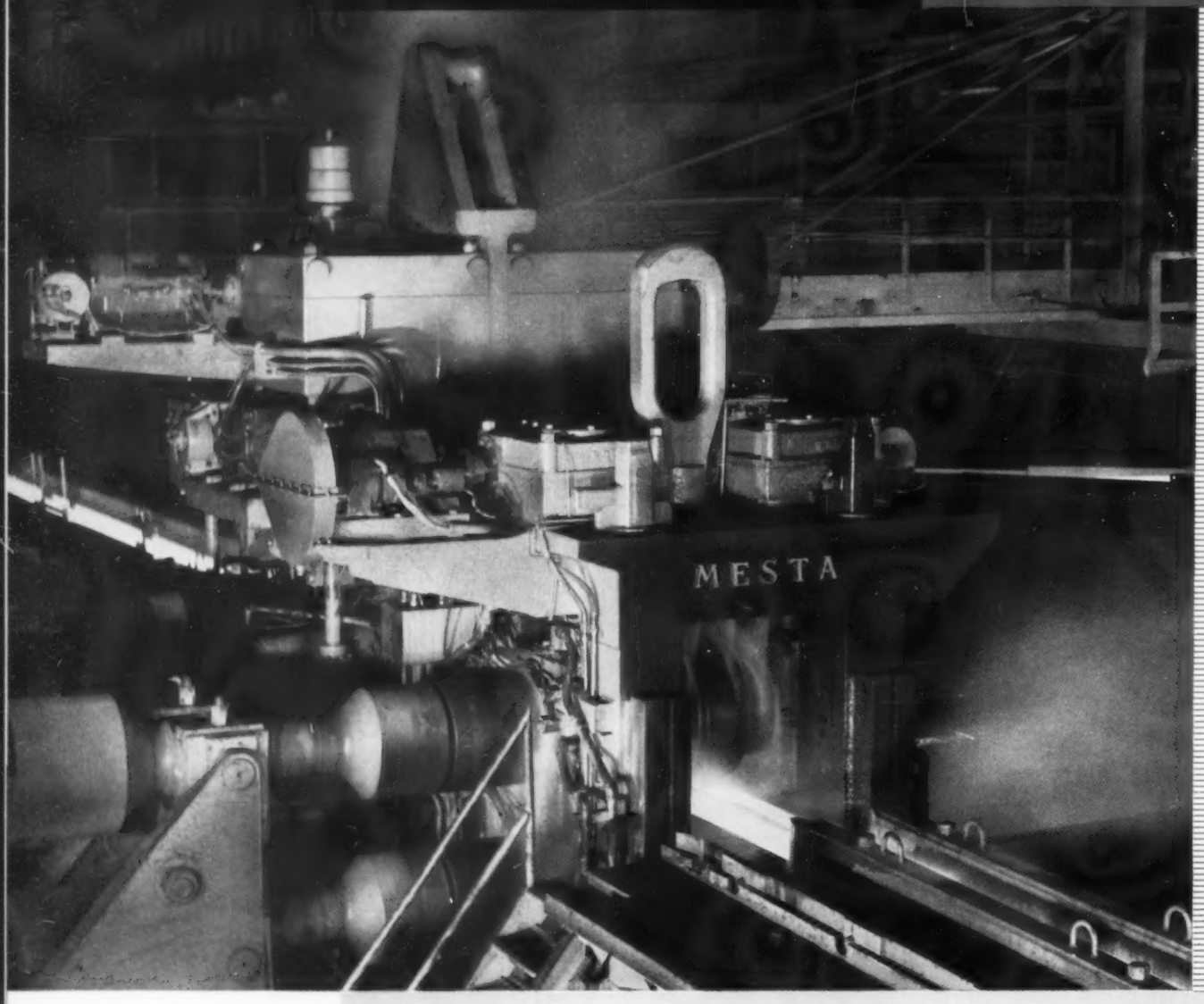
ROBERTS & SCHAEFER *Company*

130 NORTH WELLS STREET, CHICAGO 6, ILLINOIS

NEW YORK 19, N.Y. • PITTSBURGH 22, PA. • HUNTINGTON 10, W. VA. • ST. PAUL 1, MINN.

WIDE FLANGE BEAM AND STRUCTURAL MILLS

Designed and Built by MESTA



MESTA Universal Structural Mill rolling wide flange beams on the 44" Universal Stand and the 34" Edging Stand at Inland Steel Company, Indiana Harbor Works

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

MESTA
THERE IS NONE BETTER

Personnel News...

John R. Lowey, superintendent of the mechanical department, has been appointed general superintendent of the Cleveland District steel plant of Republic Steel Corp. In the newly created post he will supervise all activities at the plant under the district manager and the assistant district manager. Mr. Lowey had been appointed superintendent of the mechanical department 21 months ago. He had joined Republic at Chicago, Ill., in 1935 as a junior engineer. He advanced to foreman of the boiler and welding shop there in 1937 and four years later was promoted to general millwright foreman.

In 1945 he was named general shop foreman at the Cleveland steel plant, became assistant superintendent of the mechanical department in 1950 and superintendent in 1957. **J. Eric Heyworth** has been appointed superintendent of the Mechanical Department at the Cleveland District plant. **Joseph H. Snayd,** assistant master mechanic, was named to succeed him as assistant superintendent of the department. Mr. Heyworth joined Republic 20 years ago and advanced through various positions to master mechanic at the steel plant in 1952. In January, 1957, he was promoted to assistant superintendent of the Mechanical Department. Mr. Snayd came to Republic in 1946. He was named mechanical foreman in 1952 and assistant master mechanic in 1957.

George J. Downing has been appointed chief combustion engineer for Republic Steel Corp.'s Buffalo, N. Y., Plant. He succeeds **Walter L. Radley** who has retired. Mr. Downing has worked at Republic since July, 1947. In October of that year, he was selected for a special two-year technical operating training program, the first in a series that is still continuing. When he completed the course, he was assigned to the electrical maintenance department and in 1950 was appointed a combustion engineer.

Walter E. Watson, vice chairman, The Youngstown Sheet and Tube Co., has retired. Also retired is **Myron S. Curtis,** assistant to the president. Mr. Watson joined the National Tube Co. at Pittsburgh in 1901 as a salesman. After spending eight years at National Tube he joined the LaBelle Iron Works at Steubenville, Ohio, as assistant general manager of sales, a post he held for four years. He joined Youngstown Sheet and Tube in 1913 as assistant general manager of sales. He became general manager of sales in 1917, vice president in charge of sales in 1924, first vice president in 1943, a director in 1944 and a member of the executive committee in 1953. Mr. Watson's election as vice chairman of the board became effective December 1, 1956. Mr. Curtis spent more than 47 years of service with Youngstown Sheet and Tube. He had served in the operating, sales and executive departments since joining the company in 1911 in the Tube Mills at Campbell. The following year he was sent to Harvey, Ill., as a foreman in the Western Conduit Co. plant, a Youngstown subsidiary. Within a few months he became assistant plant superintendent. When this plant was dismantled and moved to Youngstown in 1912, Mr. Curtis returned to Youngstown as assistant superintendent of the Conduit Department at the Struthers plant. The following year he became general foreman of the Tube Galvanizing Department. Mr. Curtis became the company's first chief inspector in 1915. Four years later he was named special agent, product claims, a post he held for seven years before being appointed Youngstown district sales manager. In 1929 Mr. Curtis was named manager of sales promotion and the following year assumed the additional position of advertising manager. In 1948 he was also appointed manager of the company's Industrial Development Division. He was named assistant to the president in 1949.

Dr. F. C. Langenberg and **G. E. Hutchinson** have been appointed material and process engineers by the Crucible Steel Co. of America. Dr. Langenberg began his steel career in 1951 when he joined United States Steel Corp. as a research engineer. He came to Crucible in 1955 as supervisor of metallurgy at the research laboratory in Pittsburgh. He held this post until his present appointment. Mr. Hutchinson joined Remington Arms Co. as a research chemist in 1940. In 1951 he moved to Midland where he went to work for newly formed Rem-Cru Titanium Inc. as super-

J. R. LOWEY

J. E. HEYWORTH

J. H. SNAYD

G. J. DOWNING

T. W. MATCHETT

J. D. RILEY

H. G. ANDERSEN

R. F. BETTS

visor of process engineering and quality control. He was subsequently appointed assistant sales manager and quality control manager. After Crucible acquired full ownership of Rem-Cru, Mr. Hutchinson was named quality control superintendent, a position he held until his present appointment.

T. W. Matchett has been appointed assistant general manager of Link-Belt Co.'s Caldwell plant in Chicago, Ill. He joined Link-Belt in 1946 and has been manager of the Chicago district office since 1948. **John D. Riley** succeeds Mr. Matchett as district manager at Chicago. For the past four years he has been district manager at Cleveland and before that was district manager at Newark, N. J. He joined Link-Belt in 1934 at the Philadelphia plant and has also served at the Boston office. **Harry G. Andersen** has been appointed district manager at Cleveland, succeeding Mr. Riley. He was formerly district manager at Summit, N. J. Mr. Anderson joined Link-Belt in 1937 at the Chicago Pershing Road plant and subsequently served as sales engineer at Chicago and Milwaukee district sales offices and as district manager at Birmingham. **Harry M. Horton** succeeds Mr. Andersen as district manager at Summit, N. J. He was formerly a district sales engineer at that office. He has been with Link-Belt since 1948.

N. Stanley Snyder, district manager of Link-Belt Co.'s Buffalo office, has retired after 52 years of service with the company. He joined Link-Belt in 1906 as a clerk in the Philadelphia plant. In 1924, he was appointed district manager of the Buffalo office. **R. F. Betts,** former district sales engineer in the Boston office, succeeds Mr. Snyder as district manager at Buffalo. Mr. Betts joined the company in 1939 at the Philadelphia plant and served in engineering prior to his appointment as sales engineer in the Boston territory in 1949.

John Hellstrom, vice president of American Air Filter Co., retired November 1. He was director of AAF's Products and Marketing Division, and manager of the American Air Division (Louisville manufacturing division). Mr. Hellstrom was president of the Midwest Air Filter Co. at the time of its merger in 1926 with three other firms to form the American Air Filter Co. He later became vice president in charge of dust control products and helped pioneer the acceptance of the Roto-Clone dust collectors.

R. L. Kenyon, former associate director of structural design and administration, Armco Steel Corp., was named assistant to the vice president—research. **R. S. Burns** and **V. W. Carpenter,** both also associate directors, were advanced to director of metallurgical research and director of magnetic materials research, respectively. Mr. Kenyon has served as an associate director of Armco research since 1940. Prior to that, he was a supervising metallurgist and a supervising engineer. He joined Armco in 1920. Mr. Burns joined Armco at the Middletown works in 1930. He was transferred to the Research Division in 1930, moving up to supervising research engineer in 1938 and associate director in 1946. Mr. Carpenter became associated with the Research Division of Armco in 1930. He progressed through various research positions to become a supervising metallurgist in 1940 and associate director of research in 1955.

A. F. Prust has been named chief metallurgist of Republic Steel Corp.'s Warren, Ohio, plant. Succeeding Mr. Prust as assistant chief metallurgist is **J. E. Cleary,** a member of the plant's metallurgical department since 1955.

J. L. Montgomery has been named product sales manager, Plant Equipment, Blaw-Knox Co. He has been assistant product sales manager of the department. Formerly employed by Quigley Co., Mr. Montgomery joined Blaw-Knox as a sales engineer in 1955.

A. Brent Wilson was appointed executive vice president of Harbison-Walker Refractories Co. **A. L. Garber** will remain as president and chief executive officer. Mr. Wilson entered the employ of Canadian

J. L. MONTGOMERY

A. B. WILSON

You'll find what you want in bearings of

ALCOA ALUMINUM ALLOY

Ability to carry heavy loads . . . up to 10,000 psi on projected area.

Cooler Running . . . Aluminum is the best heat conductor among bearing materials, thus runs cooler . . . as much as 20° by actual test.

Good Conformability . . . Aluminum has good ductility, conforms readily to misalignment of shafts or nonparallel pins.

Ideal Embeddability . . . Aluminum embeds particles better than bronze, not as deeply as babbitt; dirt particles roll out easily and are trapped by filter.

Corrosion Resistance . . . Aluminum resists corrosion, is unaffected by additives in oils, needs no protective coating.

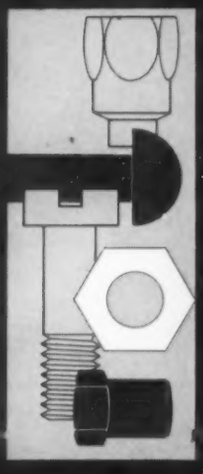
Design Flexibility . . . Aluminum has it; structural properties allow for greater flexibility in design . . . ease of machinability, too!

For more information on the unmatched combination of advantages in solid aluminum alloy bearings, call your nearest Alcoa sales office. Or, write to Aluminum Company of America, 1983-M Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM BEARINGS

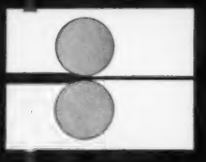
Your Guide to the Best in Aluminum Value

ALCOA THEATRE
Fine Entertainment
Alternate Monday Evenings



COLD HEADING MACHINERY

Cold Headers • Parts Formers • Nut Formers • Slotters • Threaders • Pointers • Trimmers and other Cold and Hot Forming Equipment

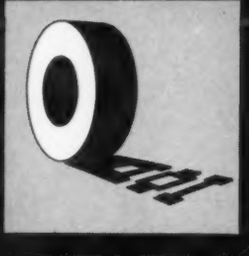


ROLLING MILL MACHINERY

Two-High and Four-High Mills • Special Mills • Sendzimir Mills • Rod Mills • Slitters • Coilers • Winders • Straighteners • Payoffs • Edgers • Coil Boxes • And Other Mill Equipment

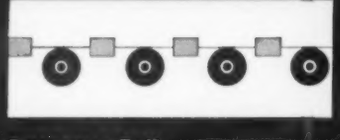
WATERBURY FARREL

MACHINERY BUILDERS



WIRE MILL EQUIPMENT

Continuous Tandem And Upright Cone Wire Drawing Machines • Bull Blocks • Wire Flattening Mills •



Swagers • Roll Pointing Machines • Spoolers • And Other Wire Equipment

POWER PRESSES

Cam and Crank Eyelet Machines • Horizontal Redraw Presses • Multiple Plunger Pillar Presses • High Speed Blanking Presses • Collapsible Tube Equipment • Ammunition Machinery, etc.

THE WATERBURY FARREL FOUNDRY & MACHINE CO.

DIVISION OF TEXTRON INC.

Waterbury, Connecticut • U.S.A.

Sales Offices: Chicago • Cleveland • Los Angeles • Millburn, N. J.

WF-51R

NATHAN COHN (left)
D. E. MOAT (center)
J. F. QUEREAU (right)

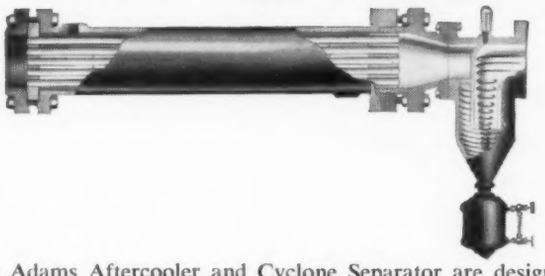
Refractories Limited, Harbison-Walker's Canadian subsidiary, in 1934. He became general manager of Canadian Refractories Limited in 1948 and was transferred to the office of the parent company in 1950 and became vice president of the parent company in 1955.

Nathan Cohn, formerly manager, Market Development Division, Marketing Dept., Leeds & Northrup Co. has been named vice president—technical affairs, a new post. Mr. Cohn will be responsible for the broad supervision of the Research & Development Dept., the Engineering Dept., and the Patent Division. At the same time **Raymond C. Machler** was named director of research and development. **G. Lupton Broomell,** director of engineering, and **J. Clarence Peters,** manager, Patent Division. **Donald E. Moat,** director of marketing, becomes vice-president—marketing, while retaining his former function. The director of manufacturing, **John F. Quereau,** retains that function and becomes also vice-president—manufacturing.

Robert S. Hammond, vice president in charge of Chicago office, Whiting Corp., retired on October 31 after forty years of service with the company. Mr. Hammond began his active business career in 1911 as a special apprentice with American Steel Foundry at Granite City, Ill. He joined Whiting in 1919 as Pittsburgh district manager. He became Chicago district manager in 1921 and was named sales manager and vice president at Whiting's Harvey, Ill., headquarters in 1930. He has been Chicago district manager since 1936.

Morse G. Dial has assumed the newly-created office of chairman of the board, Union Carbide Corp., and continues as chief executive officer. **Howard S. Bunn,** succeeds Mr. Dial as president. **Kenneth H. Hannan**

Aftercooler and Cyclone Separator designed for cleaner, dryer compressed air



The Adams Aftercooler and Cyclone Separator are designed to efficiently condense and remove water from compressed air and process gas. Condensed moisture and entrained dirt and oil are subsequently removed in a cyclone type separator. This unit is scientifically designed for maximum removal efficiency over a wide range of flow rates.

For normal use, units are available to cool gases to within 10° F of the temperature of the cooling water. Specially designed units are available to permit a 2° F approach to cooling water temperature, for application where low moisture content is critical.

Adams Aftercoolers and Separators are available from stock to handle 20 - 40,000 cfm with 10° cooling and 25 - 19,200 cfm where it is necessary to cool within 2°F of the cooling water. Special units can be supplied to suit an unlimited range of requirements. In all cases the maximum pressure loss at rated capacities is ½ psi.

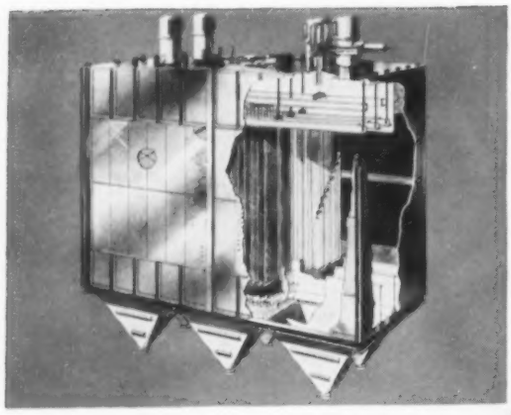
This wide range of sizes enables the economical utilization of Adams Aftercoolers and Separators in virtually all industrial application. For further information on how R. P. Adams' units will solve your compressed air problems and save you money, write today for Bulletin 711. R. P. Adams Co., Inc., 223 East Park Drive, Buffalo 17, New York.

Metal Cutting Knives *ONLY*

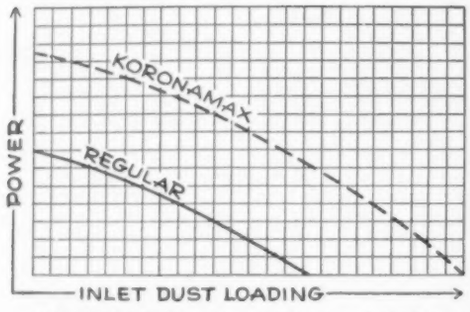
We offer forty years of experience in producing the highest quality Metal Cutting Knives and skilled craftsmen working with the finest materials to exacting tolerances.

A bulletin on "Metal Shearing Aids" will be sent on request.

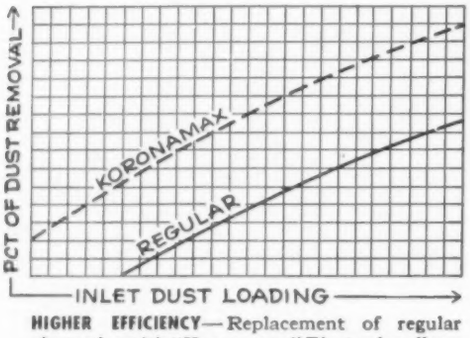
THE HILL ACME COMPANY
CLEVELAND KNIFE DIVISION
1201 West 65th St. • Cleveland 2, Ohio



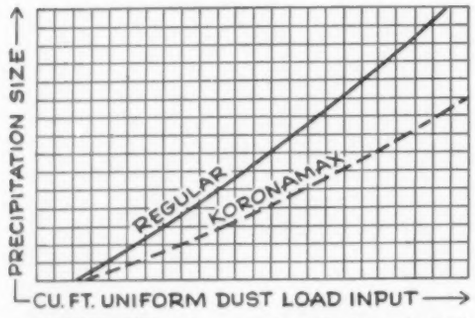
Another Koppers Exclusive in ELECTROSTATIC PRECIPITATION



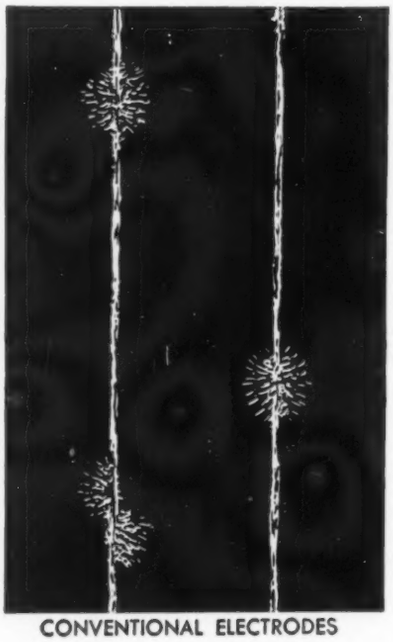
INCREASED POWER—The evenly spaced discharge points of "Koronamax" Electrodes reduce the arc-over tendency and permit increasing power input.



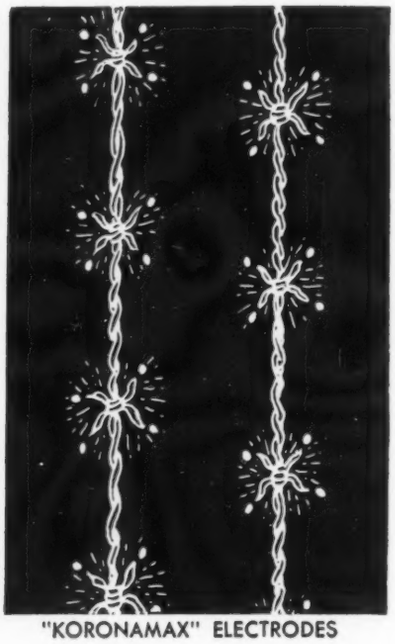
HIGHER EFFICIENCY—Replacement of regular electrodes with "Koronamax" Electrodes allows higher power input — greatly increased efficiency.



SMALLER SIZE—In new installations desired efficiency may be obtained with smaller unit when "Koronamax" Electrodes are used.



CONVENTIONAL ELECTRODES



"KORONAMAX" ELECTRODES

"KORONAMAX" ELECTRODES increase efficiency and capacity of electrostatic precipitators

"Koronamax" Electrodes developed by Koppers are now in service in several different applications and their *controlled* corona discharge has resulted in greatly increased capacity and efficiency. This unique type of precipitator electrode may solve *your* gas cleaning problem.

Koppers' experience, constant research and extensive field testing have led to this important advance in precipitator design. Check with Koppers to see if "Koronamax" Electrodes can help you get top precipitator efficiency. For more information, write: KOPPERS COMPANY, INC., 8312 Scott Street, Baltimore 3, Md.

KOPPERS

ELECTROSTATIC PRECIPITATORS

Engineered Products Sold with *Service*

continues as executive vice president and **Birny Mason, Jr.,** vice president, becomes executive vice president, succeeding Mr. Bunn. Mr. Mason and **Kenneth Rush,** vice president, have been added to the board of directors.

William F. Stowasser, Jr., has been appointed senior research engineer in the Research and Development Department of Jones & Laughlin Steel Corp. Mr. Stowasser was process development engineer, Processing Machinery Department for Allis-Chalmers Manufacturing Co., from 1947 until September of this year. His duties will include studies of agglomeration-sintering and pelletizing processes.

Gilbert A. Hanke was named product manager, stainless tubing, Allegheny Ludlum Steel Corp. Mr. Hanke will be succeeded by **Thomas J. Gorman** as general superintendent, Extrusion and Cold Draw Department at the company's Watervliet, N. Y., Works. Mr. Gorman was formerly assistant to the works manager at the West Leechburg, Pa., Works. Mr. Hanke joined Allegheny Ludlum as a metallurgist at the Forging & Casting Division in Detroit in 1942. He also served as a metallurgist in the Watervliet research laboratory for five years before being named superintendent of the extrusion department in 1952. Mr. Hanke held that post until being named general superintendent in 1955.

Edward J. Bishop has been appointed sales engineer at the Chicago, Ill., branch office for steel sales of the Timken Roller Bearing Co. Mr. Bishop joined Timken in 1957 and for the past year has been in training at the company's home office in Canton, Ohio.

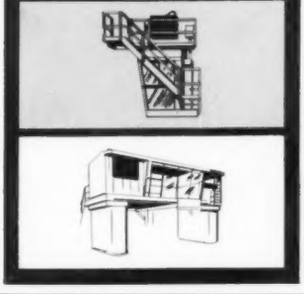
Carl A. Snider, sales engineer for the Eastern Region, Kaiser Chemicals Division of Kaiser Aluminum & Chemical Sales, Inc., has been transferred to Los Angeles. **Thomas W. Bailey** has assumed responsibility for the territory formerly covered by Mr. Snider. **Floyd A. Hixon,** formerly field installation representative in the Eastern Region, has been promoted to sales engineer and serves customers in the territory vacated by Mr. Bailey in southern Ohio and eastern Kentucky.

Obituaries

James K. Watkins, 64, chief engineer at Crucible Steel Co. of America's Midland Works, died November 13. A veteran of 42 years in the steel industry, Mr. Watkins joined Crucible in 1954. Previously he was chief engineer for Pittsburgh Steel Co.'s Monessen Works.

Edward M. Klopfleisch, assistant superintendent of foundry maintenance at Allis-Chalmers Manufacturing Co.'s West Allis Works since 1956, died November 1. He was 60. Mr. Klopfleisch had been associated with Allis-Chalmers for 29 years. Before transferring to the West Allis Works in 1954, he had been works manager of Allis-Chalmers Boston, Mass., plant for a number of years.

LINTERN



A Standard in Air Conditioning for Crane Cabs and Mill Pulpits
Over 2,000 Installations
Performance Guaranteed
Ask for Booklet AC-573

Larco. inc.

DISTRIBUTOR OF LINTERN CORPORATION PRODUCTS
ROUTE 20 EAST • PAINESVILLE, OHIO

Call or Write STAMCO for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio

ANOTHER PANNIER MASTER MARKER!

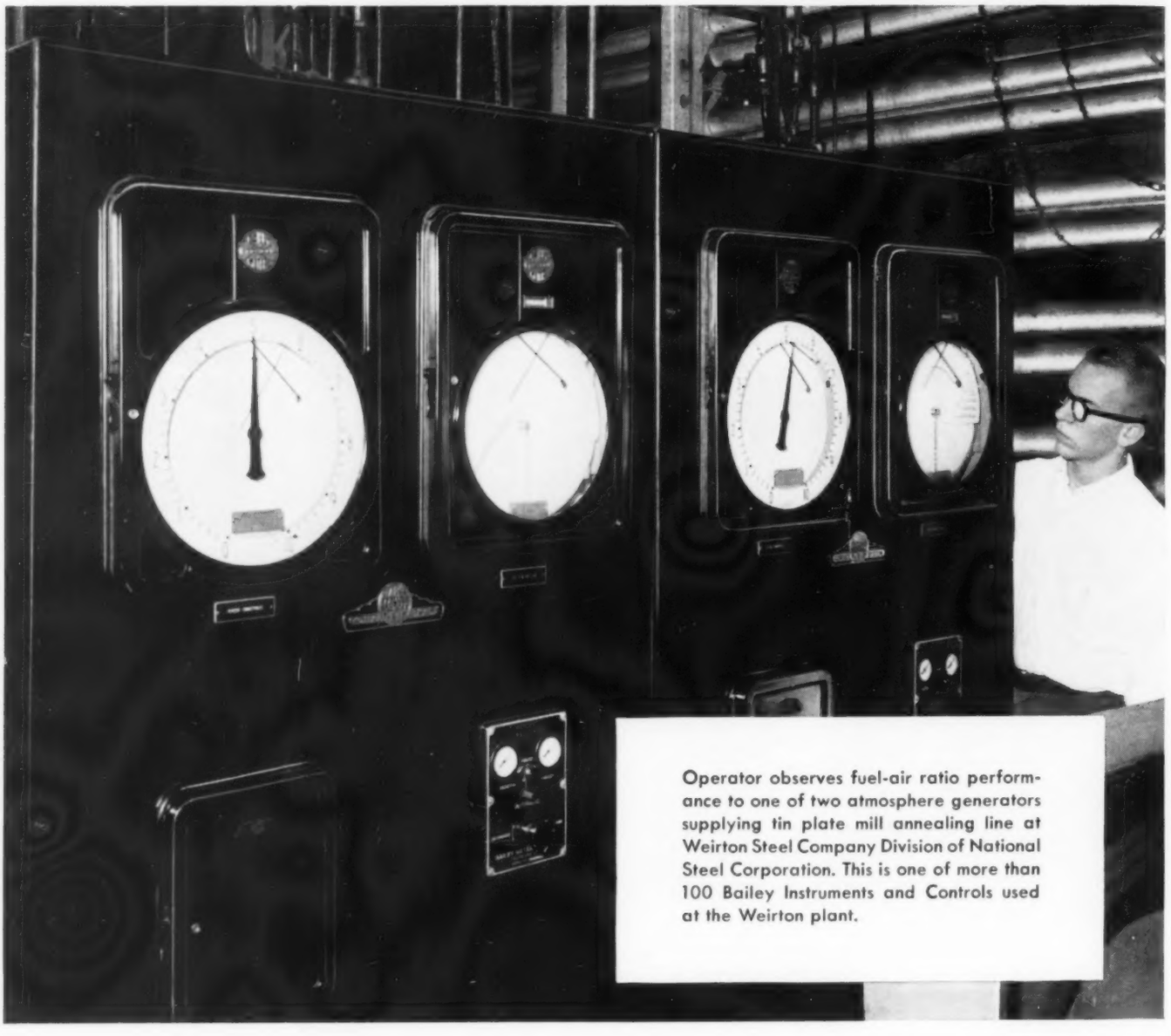
Pannier Tested Steel Stamps provide you with clear, clean markings, maximum safety, longer life and highest quality.

PANNIER'S STEEL LETTERS • FIGURES
- Longer lasting, less mushrooming
- Better impressions—clear, clean
- Letters, figures, or symbols
- In sets, assorted, or singly

BIRTHMARKED MATERIALS

Write for data. Wide variety of sizes available.

MARKING MASTER PANNIER MARKERS DEVICES
THE PANNIER CORPORATION
302 Sandusky Street • Pittsburgh 12, Pa.
Offices: Los Angeles • Chicago • Cleveland • Philadelphia • Birmingham



Operator observes fuel-air ratio performance to one of two atmosphere generators supplying tin plate mill annealing line at Weirton Steel Company Division of National Steel Corporation. This is one of more than 100 Bailey Instruments and Controls used at the Weirton plant.

Bailey Atmosphere Generator Control automatically regulates total combustibles for tin plate annealing

Bailey's Atmosphere Generator Control is a completely packaged automatic control system which measures *total combustibles* in annealing.

Manual settings are made only during start-up or shutdown. Fuel-air ratio to generators is adjusted by the control system to maintain constant total combustibles despite variation in fuel quality. Response to atmosphere changes is fast, and total combustibles are accurately measured, since the Bailey Analyzer is not subject to errors due to variability of other atmosphere constituents. The Analyzer is sensitive to changes of less than $\pm 0.02\%$ total combustibles.

The performance of this instrument is assurance of final product quality. See your Bailey Engineer, or write the Iron and Steel Division for more information.

S112-1

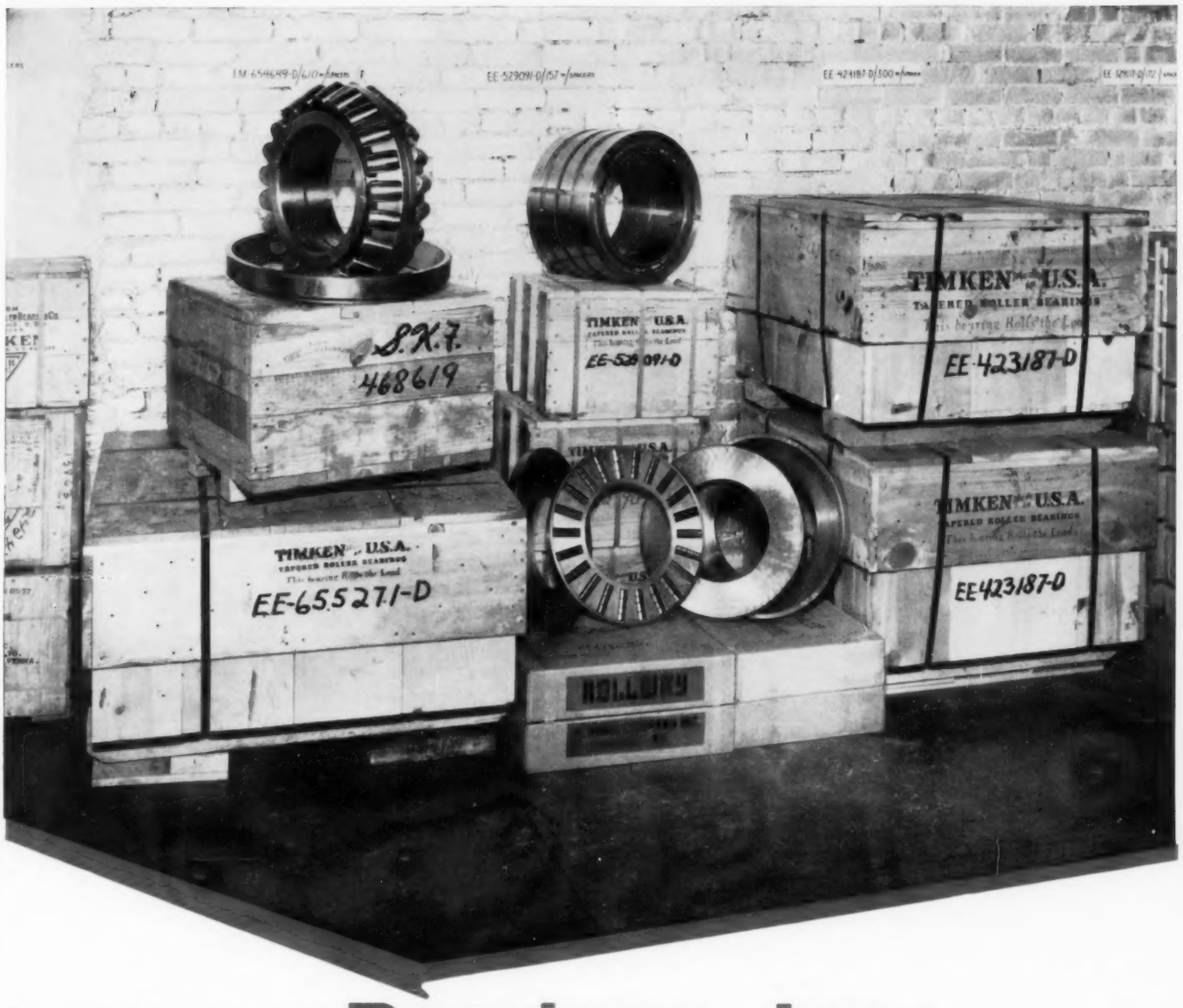
IRON AND STEEL DIVISION

BAILEY METER COMPANY

1047 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS



In stock at Bearings, Inc.

. . . steel mill work roll, back-up roll, roll neck bearings ready to ship!

If you know bearing numbers—a check of those in the photograph will tell you they are among the largest and most expensive precision, steel mill bearings made. These and many other steel mill bearings, large and small, are ready in Bearings, Inc. stock for immediate delivery!

Why carry heavy inventories of these expensive bearings? Our large stocks for replacement "on the mill" or "off the mill"—bearings for all types of mill tables, coils, cranes and mill motors as well as ingot car bearings and pallet wheels can be ordered and delivered immediately!

No other bearing distributor carries a comparable stock of steel mill bearings ready for every emergency. If you want steel mill bearings in a hurry, call or write NOW!

Shown in the photograph are only a few of the many steel mill bearings in stock. Left, a SKF Back-up Roll Thrust Bearing sits on a 2,000 lb. Timken Back-up Roll Bearing. Center, Timken Work Roll Bearings and Rollway Self-Aligning Thrust Bearings. Right, in boxes, are a pair of matched Timken Back-up Roll Bearings.

Providing bearing service in the North ➤ **BEARINGS, INC.**

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Lockland • Mansfield • Toledo • Youngstown • Zanesville
INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute • **PENNSYLVANIA:** Erie • Johnstown • Philadelphia • Pittsburgh • York
WEST VIRGINIA: Charleston • Huntington • Parkersburg • Wheeling • **NEW JERSEY:** Camden
NEW YORK: Buffalo, Balanrol Corp. • **MARYLAND:** Baltimore • **DELAWARE:** Wilmington

and in the South ➤ **DIXIE BEARINGS, INC.**

FLORIDA: Jacksonville • **GEORGIA:** Atlanta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge • New Orleans
N. CAROLINA: Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport • Knoxville • Nashville

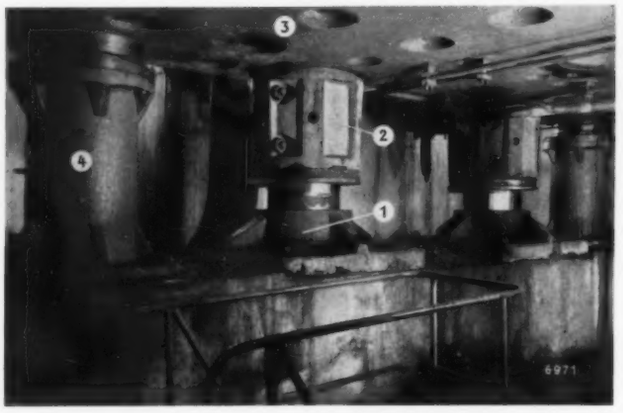
FELLER ENGINEERING CO.

presents

SCHLOEMANN

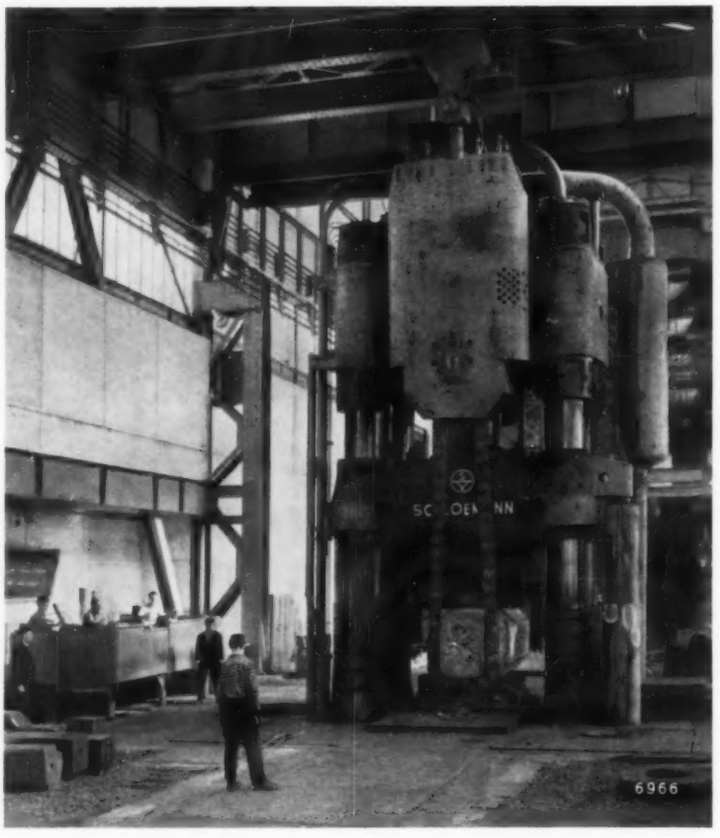
4,500 ton open-die forging press

The movements of press and auxiliary equipment are controlled from a desk. The electrical drive for the controls permits quick changing of pressure stages during operation, and the switching over from normal forging to automatic quick forging (65 strokes/min.). The stroke sequence is so rapid that the capacities of both cranes and manipulators are fully utilized. As a consequence, substantially more shaping work can be effected in one heat than has previously been possible.



Support of the press on the foundation ① shoe plate for column ② column nut ③ entablature ④ support

4,500 ton forging press in a German special steel works. Press and cranes are controlled from the stand.



Particulars of design

The press ram, the return rams and the controls are freely accessible. Both the moving crosshead and cylinder crosshead are of narrow design to permit the forging of short ingots. The moving crosshead has spherically supported guide bushes—an advantage for off-center work. The distance between the columns permits the use of a heavy manipulator. The press is supported on the shoes without anchoring. Four entablature supports secure the press from tilting. There are no counternuts above the entablature so that damage to the columns by notch effect from threads is impossible. The columns are securely held in the entablature by conical bushes. Main advantage of this anchorless design: Damage to the press foundation is completely eliminated.

Technical data

Power . . . . . .1,750/2,750/4,500 tons	Hydraulic auxiliary equipment . . . saddle shift long-stroke bilateral shifting table lifting tackle for auxiliary tools
Ram stroke . . . . . 78 in.	Air-hydraulic accumulator . . useful contents . . 330 gals; operating pressure 4,470 PSI
Daylight . . . . . 156 in.	3 three-stroke pumps . . . . each 170 gals/min
Column centers . . . . . .140 x 90 in.	
Maximum ingot . . . . . 110 tons	

FELLER ENGINEERING CO., 1161 EMPIRE BUILDING, PITTSBURGH 22, PA.

POOLE Flexible Couplings

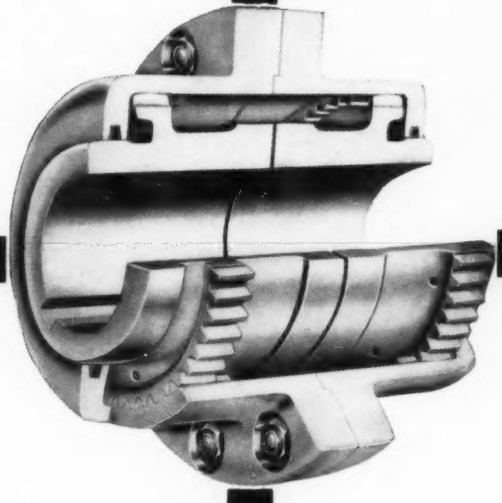
Look at these features—many of them exclusive with the patented POOLE:

Adjusts itself to all conditions, leaving its members free to float without strain to parts.

Geared type providing great strength, the highest efficiency of modern flexible coupling design.

No flexing materials to crystallize or break . . . No welded parts . . . Filled with oil, self-lubricating . . . Oil tight, dust tight . . . Permits free lateral float . . . Stronger than shafts it connects . . . Compensates for both off-set and angular misalignment.

Steel mill drives equipped with POOLE FLEXIBLE COUPLINGS.



Get the whole story from our handbook, "Flexible Couplings." A copy will be sent gladly without obligation.

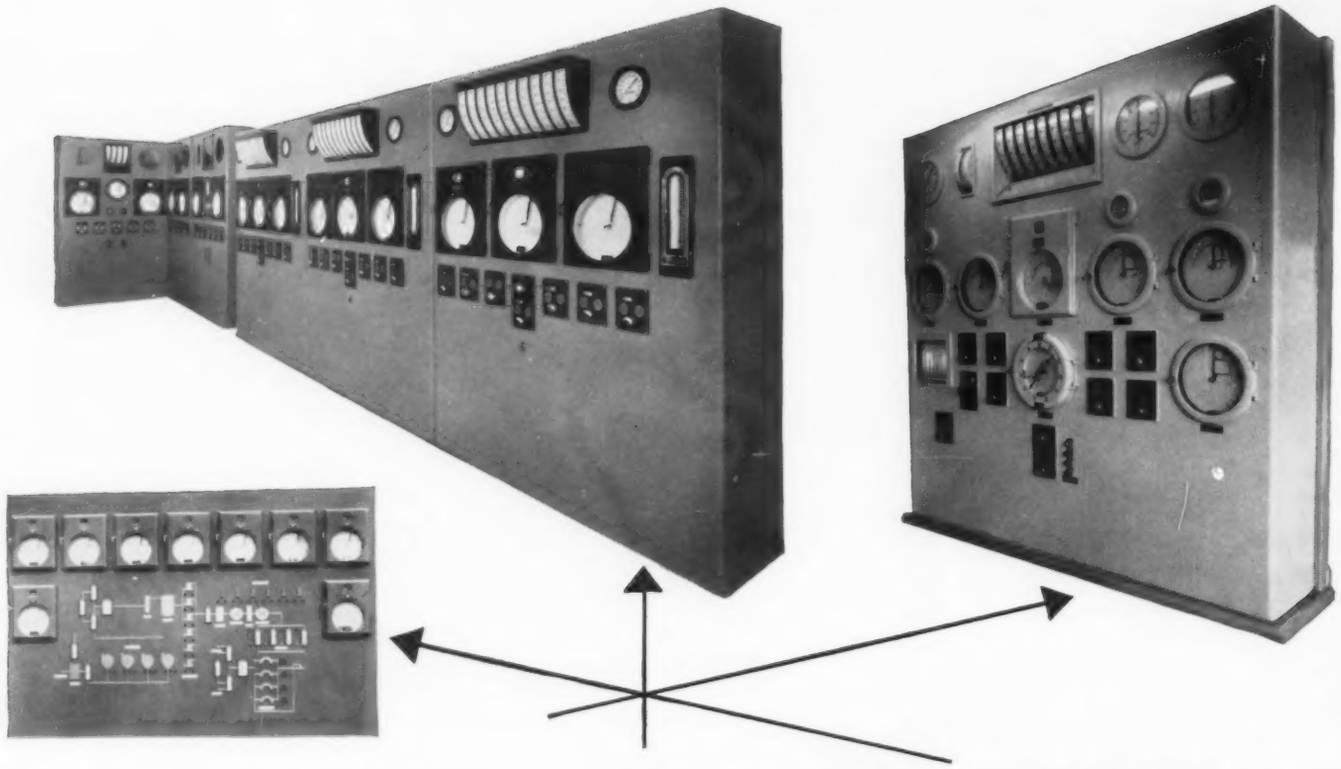
the better

FLEXIBLE COUPLING

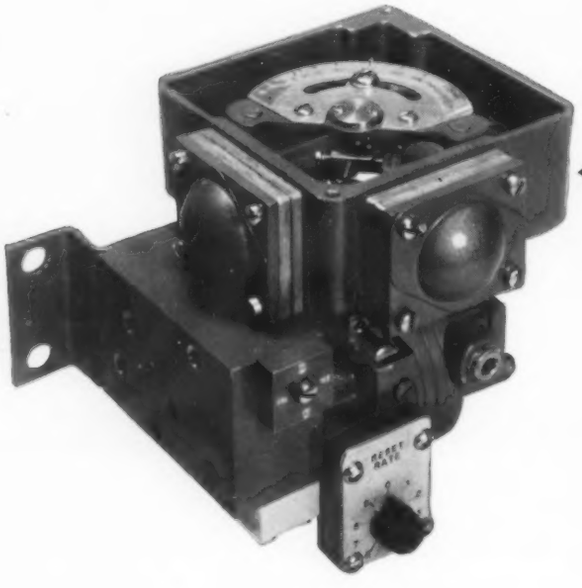
POOLE FOUNDRY & MACHINE COMPANY

1700 UNION AVE.

BALTIMORE 11, MD.



Base Any Of These



ON THIS

For accurate, efficient, dependable control systems— REPUBLIC'S NEW TYPE "VC" PNEUMATIC CONTROLLER

Here is an all purpose null-balance-vector controller for use with any pneumatic transmitter. Its proportional band ranges from 2% to 500% *without changing parts*, for quick adaptation to changes in process requirements. Especially important in high-precision control, Republic's Type VC has exceptional sensitivity and a narrow dead band (less than 0.05%). Its high capacity non-bleed pneumatic amplifier consumes little air, keeps output ample. A selector block permits reverse or direct action; local or remote pneumatic set point optional.

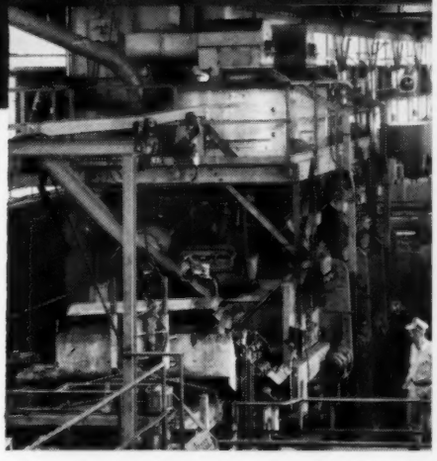
Companion instruments—using an identical null-balance-vector "heart"—include differential pressure, temperature and pressure transmitters . . . ratio, totalizing, multiplying, squaring and square - root - extracting relays. Many parts are interchangeable among the instruments in this "family". Besides reducing spare parts inventory, the similarity of components simplifies the task of training personnel.

Let a Republic engineer show you how these instruments can help to achieve accurate, efficient, dependable control systems. Republic Sales Offices are located in principal cities throughout the U.S.A. and Canada.

REPUBLIC FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
2240 DIVERSEY PARKWAY CHICAGO 47, ILLINOIS
In Canada: Republic Flow Meters Canada, Ltd.—Toronto
Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

One of the most efficient manufacturing operations in industry today is the production of automobile frames. For better, faster descaling, three of the four producers in this field have selected Pangborn Rotoblast Descaling Equipment.



ROTOBLAST replaces pickling at Midland Steel.

Clean it fast with **Pangborn** *ROTOBLAST®*

PANGBORN CORPORATION, Hagerstown 9, Maryland

Manufacturers of Blast Cleaning and Dust Control Equipment

News and Notes on...

Good Packing Practice

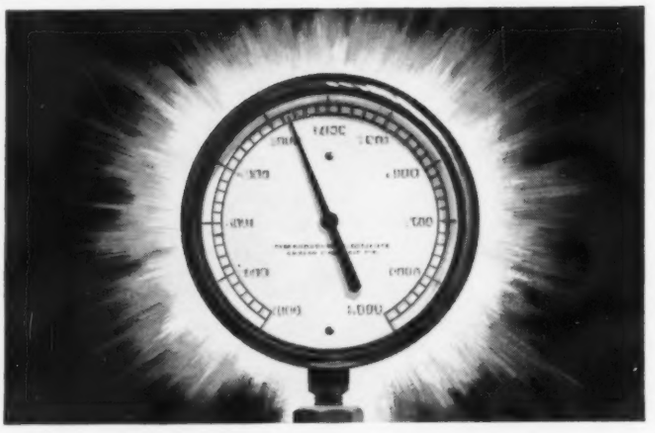
JOHNS-MANVILLE JM PRODUCTS

Maintenance and Design Hints from Johns-Manville Packings and Textiles Dept.

Subject of the month: High Operating Pressures

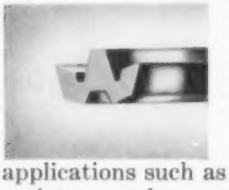
Problem:

How can today's process industries and equipment meet the requirements to stay "on stream" in the face of increasing burdens placed on packings by higher operating pressures?



Condition 1

FOR RODS AND PLUNGERS WORKING AT 2,000 TO 3,000 PSI, MOULDED UNEEPAC® RINGS



Wherever reciprocating machinery calls for a minimum of downtime and maximum efficiency in the face of high pressures, Uneepac rings have proved universally dependable. Manufacturer's life tests and applications such as hydraulic presses, pump rods, accumulators, and compressors show Uneepac takes hundreds of thousands of cycles without replacement. Quality materials and carefully engineered design and construction are the key to Uneepac's success in thousands of high-pressure applications. For information on J-M Moulded Packings, write for new, free booklet, PK-126A.

Condition 2

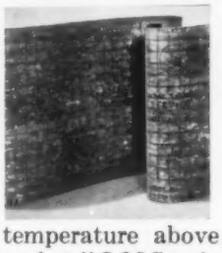
FOR VALVES OPERATING AT PRESSURES TO 5,000 PSI

Tough J-M Chempac® Teflon®-asbestos valve stem packing, Style 2011, combines the heat resistance of asbestos and the corrosion resistance of Teflon. Specify this long-life packing for high-pressure applications to 5,000 psi at temperatures to 500F. In some special cases it has withstood 50,000 psi. You'll find complete details on Johns-Manville's broad line of Chempac Packings in booklet PK-124A. Write for your copy today.

For information on any Johns-Manville Packings and Gaskets, write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

Condition 3

SHEET GASKETS FOR PRESSURES TO 1200 PSI (A QUICK RULE OF THUMB)



To determine whether a job calls for a sheet gasket or a metallic gasket, try the following rule of thumb: "Multiply operating pressure (psi) by operating temperature (°F). If the product does not exceed 250,000, J-M Service® Sheet gaskets can be used. Pressures above 1200 psi or temperature above 850°F, usually call for a metallic gasket." J-M Service Sheet No. 60 effectively seals against heat, cold, water, steam, oils, mild acids and caustics.

Condition 4

FOR STANDARD FLANGE APPLICATIONS TO 6,000 PSI

When you run into the problem of extreme pressures and extreme pressure variations, specify Spirotallic® spiral-wound, metal-asbestos Goetze gaskets. Offering high mechanical strength and resilience, Spirotallic Gaskets seat readily under light bolting. Their special interlocking design and stainless steel construction effect and maintain a tight seal in the face of wide temperature and pressure variations. Write for booklet PK-35A.

JOHNS-MANVILLE

100 YEARS OF QUALITY PRODUCTS . . . 1858-1958

HOW YOUR PLANT CAN PROFIT FROM THIS MAN'S SKILL. Dowell engineers are experts in the use of chemical solvents to remove scale and sludge—those profit-robbing deposits that cut the capacity of your process systems, tanks, piping. Using the Dowell method of chemical cleaning you get more throughput, less down time—to make possible greater overall plant efficiency.

Here's how one corporation employed the skill of the Dowell engineer and his group: Following construction and before the plant was put on stream, the company called in Dowell to remove mill scale.

Total cost of this mill scaling service was $5000. Once in production the plant did not have a single major shut-down for maintenance due to mill scale. Management of the plant credits Dowell service with helping them net an operating profit of somewhere between 10 and 20 times the cost of the chemical cleaning. That amounted to between $50,000 and $100,000 the first year.

With Dowell service you get 15 years experience in chemical cleaning, full lines of equipment and chemicals—plus an engineered job—performed by trained crews.

Every type of industry can profit from Dowell methods of chemical cleaning. Ask your maintenance and operating engineers if they have all the facts—the profit possibilities—on Dowell service. DOWELL—A SERVICE DIVISION OF THE DOW CHEMICAL COMPANY. Headquarters and research center, Tulsa 1, Oklahoma; 165 offices and stations to serve you.

Chemical cleaning services for industry DOWELL

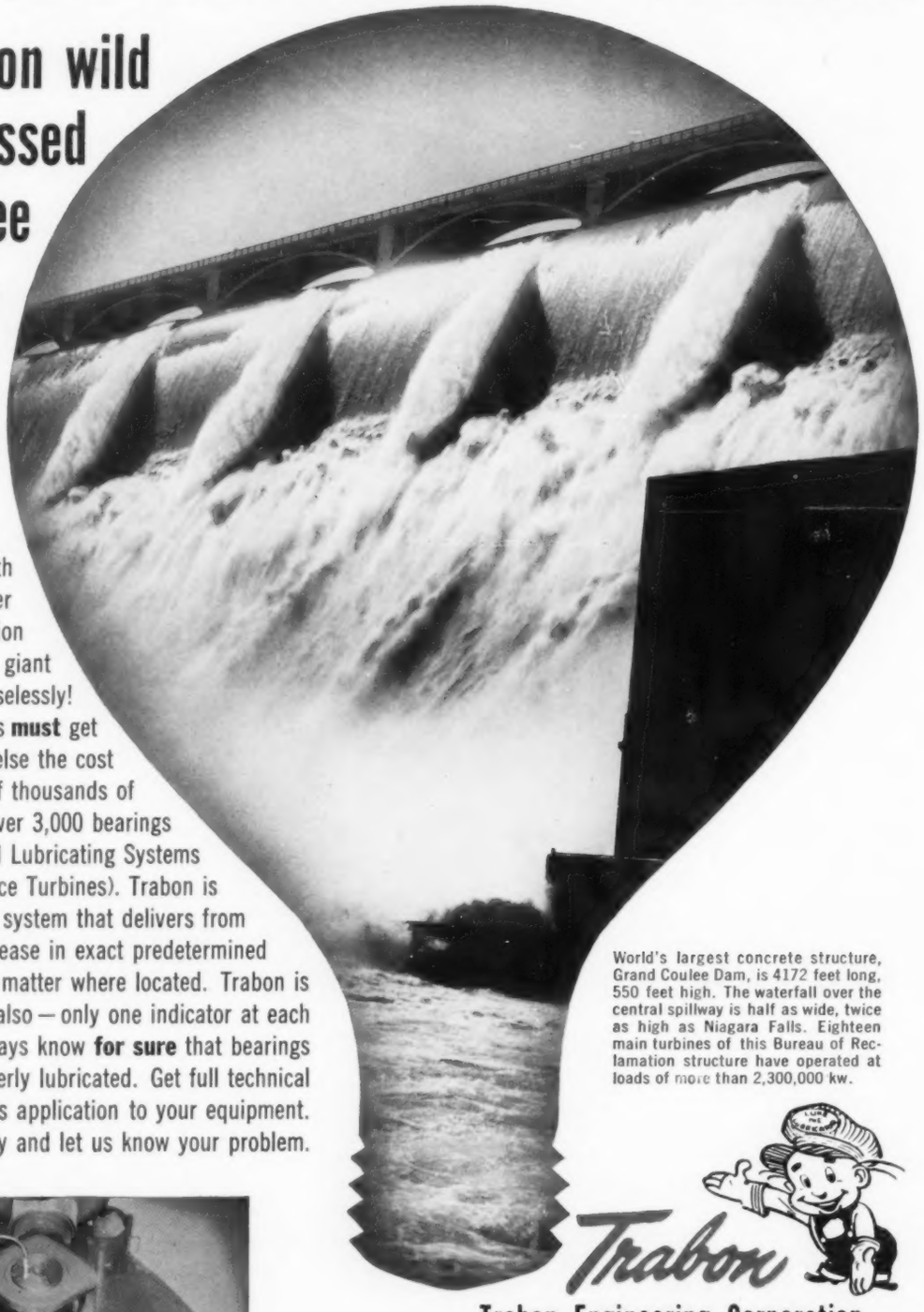
TRABON

CENTRALIZED LUBRICATING SYSTEMS

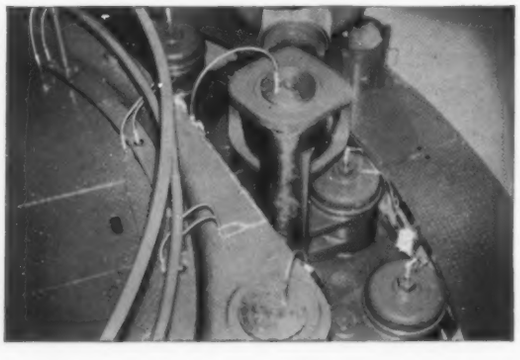
Two million wild horses harnessed at Grand Coulee

Giant turbines of world's largest dam lubricated by Trabon

The world's largest hydroelectric power plant, Grand Coulee Dam, keeps rein on the raging Columbia River with its over two million horsepower potential. **Think** of the lubrication job involved here! Eighteen giant hydraulic turbines revolving ceaselessly! Here's one place where bearings **must** get the lubricant they need or else the cost could run into the hundreds of thousands of dollars. On-the-job protecting over 3,000 bearings are 21 Trabon Centralized Lubricating Systems (including 3 Station-Service Turbines). Trabon is the economical single line system that delivers from a central location oil or grease in exact predetermined quantities to bearings no matter where located. Trabon is centralized in indication, also—only one indicator at each turbine is needed. You always know **for sure** that bearings have been properly lubricated. Get full technical details on Trabon's application to your equipment. Write today and let us know your problem.



World's largest concrete structure, Grand Coulee Dam, is 4172 feet long, 550 feet high. The waterfall over the central spillway is half as wide, twice as high as Niagara Falls. Eighteen main turbines of this Bureau of Reclamation structure have operated at loads of more than 2,300,000 kw.



"Whitened" lubricant lines and feeders show part of **one** of 21 Trabon systems helping to keep Grand Coulee Dam turbines operating. Note simplicity of Trabon installation.

Trabon Engineering Corporation

28785 Aurora Road • Solon, Ohio

Centralized OIL AND GREASE SYSTEMS *Matic-flo* CIRCULATING OIL SYSTEMS

Equipment News...

ALUMINUM COLD MILL

Δ A new 66-in. bright mill with the latest refinements for high-speed cold rolling of aluminum sheet is being readied for operation at the Reynolds Metals Co. Alloys Plant near Sheffield, Ala.

Designed and built by E. W. Bliss Co., the two-high, single-stand cold mill is the first of its type to be installed by Reynolds for sheet operations.

With a maximum speed of 1000 fpm, the new mill can reduce sheet thickness approximately 50 per cent. It can handle a gage of from 0.10 in. down to 0.006 in. Maximum strip input width is 63 in.

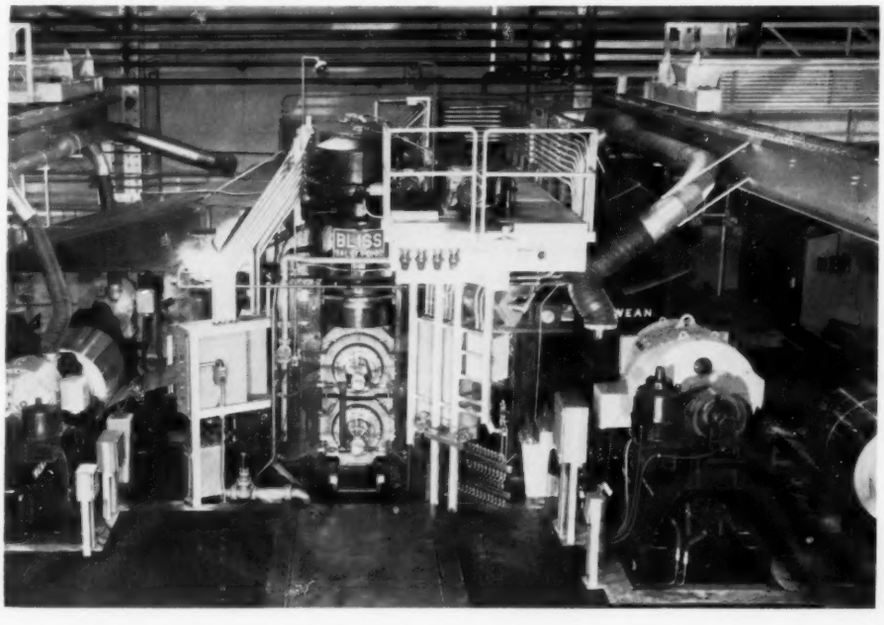
Work rolls are 36 in. in diam. The mill is powered by a 1250-hp Westinghouse electric motor.

To insure clean coolant at all times, the new mill features a continuous line-flow filtering process.

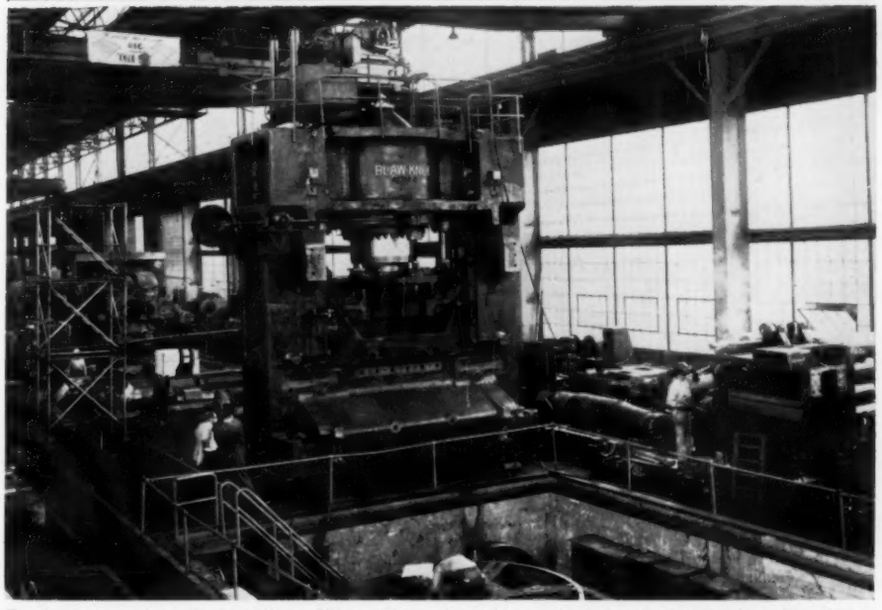
A specially designed heating system maintains proper shape of the work rolls, a major problem in mills of less advanced design. A similar system preheats rolls in an adjacent storage area, eliminating the need for a preproduction "warm-up" after a roll change.

The latest in electronic controls on the mill permit the operator to spot—through his complete control panel—difficulties at any point in the rolling operation. Electronic controls also maintain gage consistency in high-speed acceleration and deceleration.

This 66-in. bright finish cold rolling mill is the first of its type to be installed by Reynolds Metals Co. for sheet rolling. The high-speed mill is expected to be of special interest to industries requiring an extremely bright finish on aluminum sheet. It features the latest refinements for continuous quality control.



HYDRAULIC SHEAR FOR GARY MILL



Designed and built by Blaw-Knox Co., this three thousand-ton hydraulic shear will be installed in U. S. Steel Corp.'s Gary Steel Works to cut hot slabs rolled in the new Universal slabbing mill now being erected. The shear has a knife pressure of 6,000,000 lb.

COIL INSULATION

Δ A complete insulation system which seals field coils against contaminants is available from Allis-Chalmers Manufacturing Co. for synchronous and d-c motors subject to severe duty cycling in class A, B and H temperature applications.

"Integrated" construction, which locks coil structures against destructive mechanical forces and eliminates heat aging, is bonded with epoxy-type resins and locked in a glass fiber laminate. Materials are resilient, have good adhesive qualities and dimensional stability. The finished insulating structure is fused together into one integral part.

Synchronous motors and generators with "Integrated" field coils are applicable in areas where chemicals, oily vapors or moisture would

otherwise limit service life. Atmospheres containing metallic dusts, carbon black or gritty sand are not limiting factors; even in the most severe applications, mechanical forces of heat, vibration and shock loading cannot damage these coils.

VOLTAGE REGULATORS

△ A complete line of single-phase step voltage regulators in 27 distribution ratings has been announced by Pennsylvania Transformer Division, McGraw-Edison Co. The new product line is said to offer many of the design and construction features of the company's "Pole Star" distribution transformer, after which the regulators have been named. Both station-type and pole-type units are available—the latter with hold-down lugs to facilitate platform installation.

Available sizes include voltages from 2500 through 14,400 volts and current ratings from 15 through 668 amperes. A special "Mor-Amp" feature permits the regulating capacity to be increased to as much as 160 per cent of rated current, at reduced range.

Regulators with current ratings above 320 amperes are equipped with a direct-drive tap changer. Both the direct-drive tap changer and the spring-drive tap changer used on lower rated regulators have arc-resistant contacts and operate at controlled speeds that reduce contact erosion.

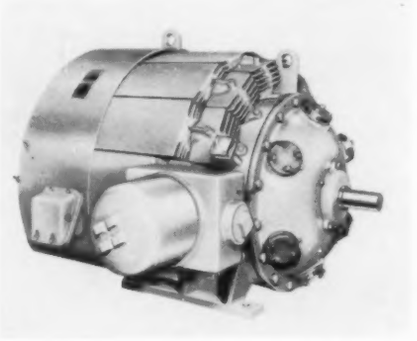
Other operating features include a bridging reactor that prevents voltage interruptions and dips during tap changes, and an integrating time delay that prevents unnecessary tap changes. A cover-mounted position indicator shows the exact tap position at all times.

The control cabinet may be easily removed from the regulator for relocation at the base of the pole or elsewhere. The cabinet contains adjustment knobs for voltage level, integrating time delay, reactance compensation and resistance compensation, and also an operation selector switch, operation counter, potential test terminals, and meter shelf. The operating band width also may be adjusted to satisfy local conditions.

The cover, cover accessories and internal assembly form an integral unit, which facilitates untanking of the regulator for inspection, and also promotes quality construction by permitting all connections to be made before the unit is tanked.

HEAT EXCHANGER MOTOR

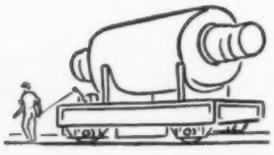
△ The Louis Allis Co. recently announced a new d-c heat exchanger motor designed to provide a wide adjustable speed range. The motor is also intended for constant speed

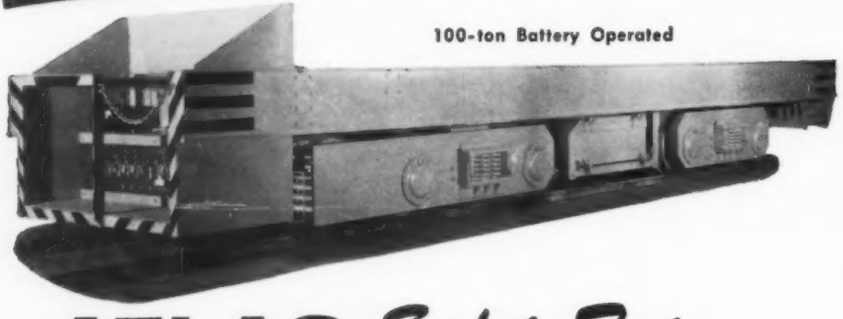


applications and is available in ratings from 25 to 300 hp.

The motor is constructed in an explosion-proof enclosure (Class I, Group D Underwriters Label) for hazardous installations and with standard enclosed construction for

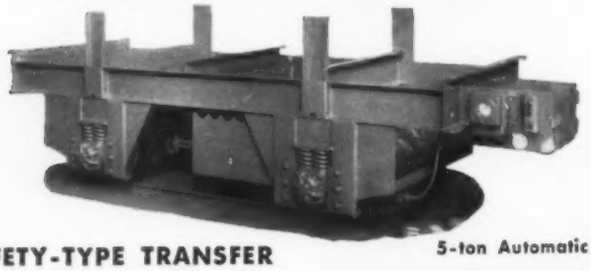
HANDLES THE BIG LOADS WITH BIG SAVINGS





100-ton Battery Operated

ATLAS *Safety Type* TRANSFERS



5-ton Automatic Controlled

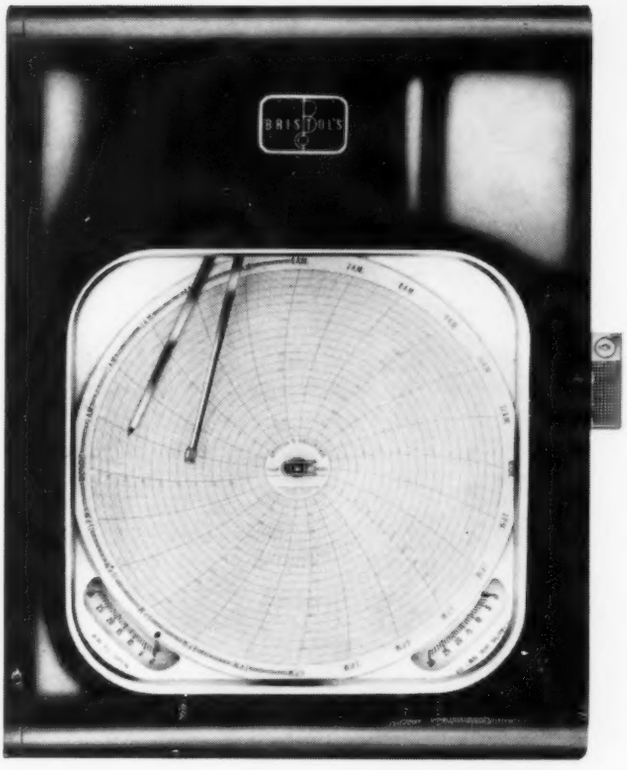
ATLAS SAFETY-TYPE TRANSFER CARS can be provided in almost any capacity for storage battery, diesel or gas-electric, or cable reel service.

They are safe because there is only one control lever, and the car moves only when the operator holds the lever.

Request "Walk-Along" Bulletin 1283.

ATLAS CAR & MFG. CO.
1100 IVANHOE ROAD
CLEVELAND 10, OHIO

ENGINEERS AND MANUFACTURERS SINCE 1896



Your newest man can operate and maintain this controller

He'll catch on quick to the Bristol Series 500 Controller without a complicated, lengthy training period.

In fact, your plant can have Bristol Series 500 Controllers, even if you don't have a formal instrument department at all. Many small instrument users are doing this today. Yet the 500's performance is such that one of the largest, most widely known chemical companies in the country just bought seventy 500's for its exacting processes.

Here are the big reasons the 500's a favorite with all instrument users, both large and small: (1) Basic simplicity of the operating mechanism; (2) Bristol measuring elements insure the utmost accuracy.

Another big simplification: You can exactly calibrate the Series 500 Controller with only one single adjustment, even after complete disassembly and reassembly with replacement of parts.

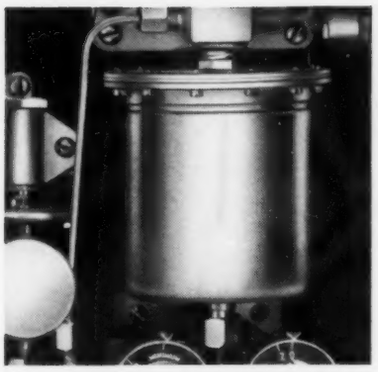
Get complete data on Bristol Series 500 Pneumatic Controllers now, before you order another instrument. Write for bulletin A 130, The Bristol Company, 123 Bristol Road, Waterbury 20, Conn. 8-19

Several hundred standard models meet every process requirement including:

These problems:	These operating modes:
1. Cascaded control	1. Fixed narrow band (on-off)
2. Selective control	2. Proportional—to 100% and to 30%
3. Ratio control	3. Reset with wide band—to 400%
4. Time program control	4. Derivative (rate)
5. Pneumatic Transmission	5. Reset plus derivative

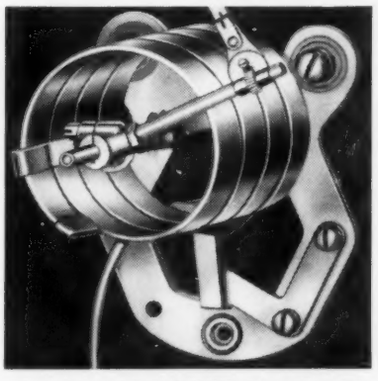
BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

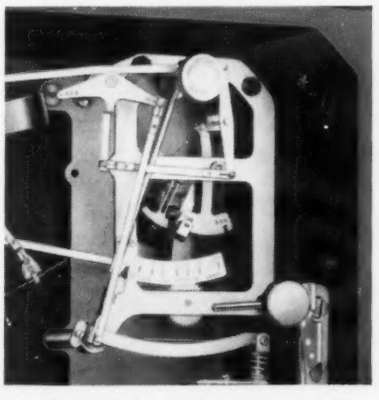


Reset Action Stops (in cylinder), another Bristol exclusive on reset models.

Zero Derivative Setting, exclusive with Bristol on derivative models.



Precision Bristol Measuring Elements insure accuracy.



Built-in Calibration assures permanent accuracy of controller action.

In parallel shaft drives . . . look for

resistance to shock and overloading

Ball and roller bearings are of ample size and capacity to withstand shock and overloading.

Under the shocks and overloads that are often encountered by parallel shaft gear drives, rugged housing construction is vital if shaft alignment is to be maintained. That's why Link-Belt adds special reinforcement at points of greatest stress . . . has developed this design expressly for endurance in heavy-duty service.

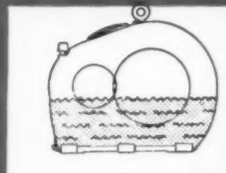
Write for your copy of Book 2619 on this broad line with ratios to more than 300:1. Or get first-hand information from your nearest Link-Belt office or authorized stock-carrying distributor.

LINK-BELT

SPEED REDUCERS

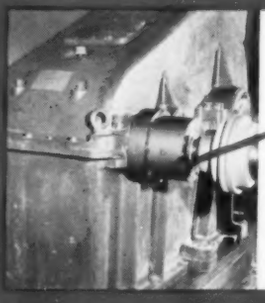
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,757

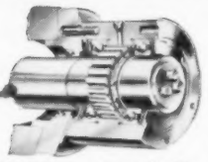
You'll find it . . . and these "plus" performance features . . . when you specify LINK-BELT



Automatic splash lubrication reliably supplies oil to all gears and bearings.

Grease-lubricated seals on all input and output shafts prevent entrance of dirt, water.





Backstop automatically prevents reverse rotation of output shaft due to power stoppage or other causes.

protection against abrasive airborne particles, dirt, coolants, moisture, oil vapors and other severe atmospheric conditions.

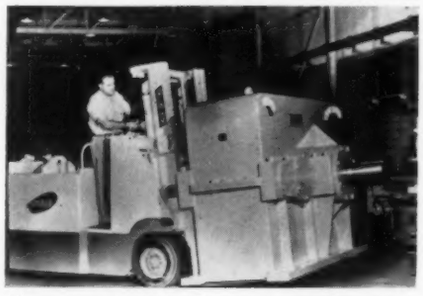
The range of adjustable speed extends from 5 per cent of base motor speed by armature control (constant torque) to 400 per cent of base speed by field control (constant horsepower). A major factor in broadening this adjustable speed range and in reducing motor size to a minimum is the use of an integrally mounted a-c fan motor to supply a constant flow of cooling air regardless of the speed of the d-c motor.

Heat exchanger tubes of heavy-section, high tensile strength aluminum alloy are distributed around the periphery of the field ring for effective air-to-air heat removal. Heavy rolled steel field ring and cast steel bearing brackets are also used to equip the motor for rigorous industrial service. The motor can be mounted floor horizontal, wall or ceiling horizontal or vertical with the shaft up or down.

HEAVY-DUTY TRUCK

△ The first model in a new series of heavy-duty electric industrial trucks, the Titan Series, engineered to provide the ultimate in maneuverability, travel and lift speeds, operator vision, and over-all safe operation, has been announced by the Elwell-Parker Electric Co.

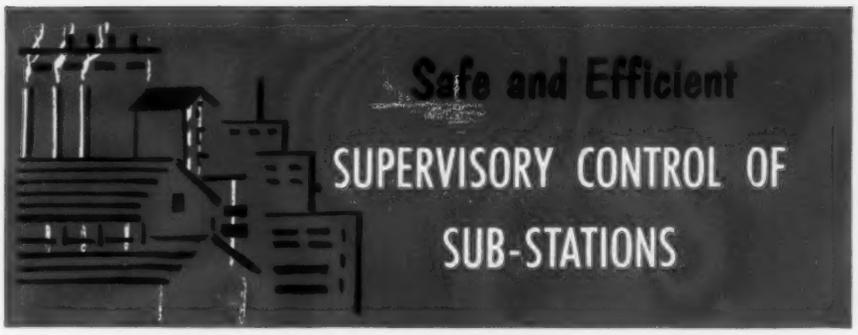
The new trucks, which provide capacities from 15,000 to 20,000 lb, have been especially designed for



the rough handling operations in steel mills, foundries and similar plants.

Outstanding features in this first model are its speed and maneuverability. In spite of its heavy-duty capacity, the truck illustrated is only 50 in. wide and 99 in. long (less forks).

Wheelbase is 66 in. and the right angle stacking aisle dimension is only 109 in. plus the length of the



A NEW FEMCO CONTROL SYSTEM

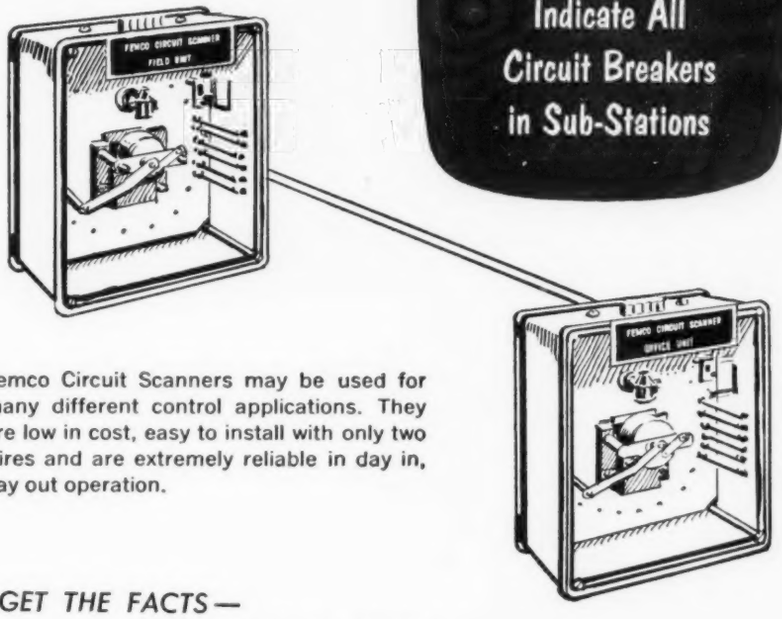
New Femco Circuit Scanners Now AC or Battery Operated

Using a single pair of wires, the system will provide supervisory control of all circuit breakers in sub-stations. Any number of stations may be wired to a central control cabinet in a single system.

Because the control equipment is powered from a separate source independent of the equipment being monitored, systems are safer to use with little chance of simultaneous power failure.

Systems may be installed to operate all on AC power or AC with standby battery or all battery-powered. Regardless of power used, the system always will be in synchronization.

Control and Indicate All Circuit Breakers in Sub-Stations

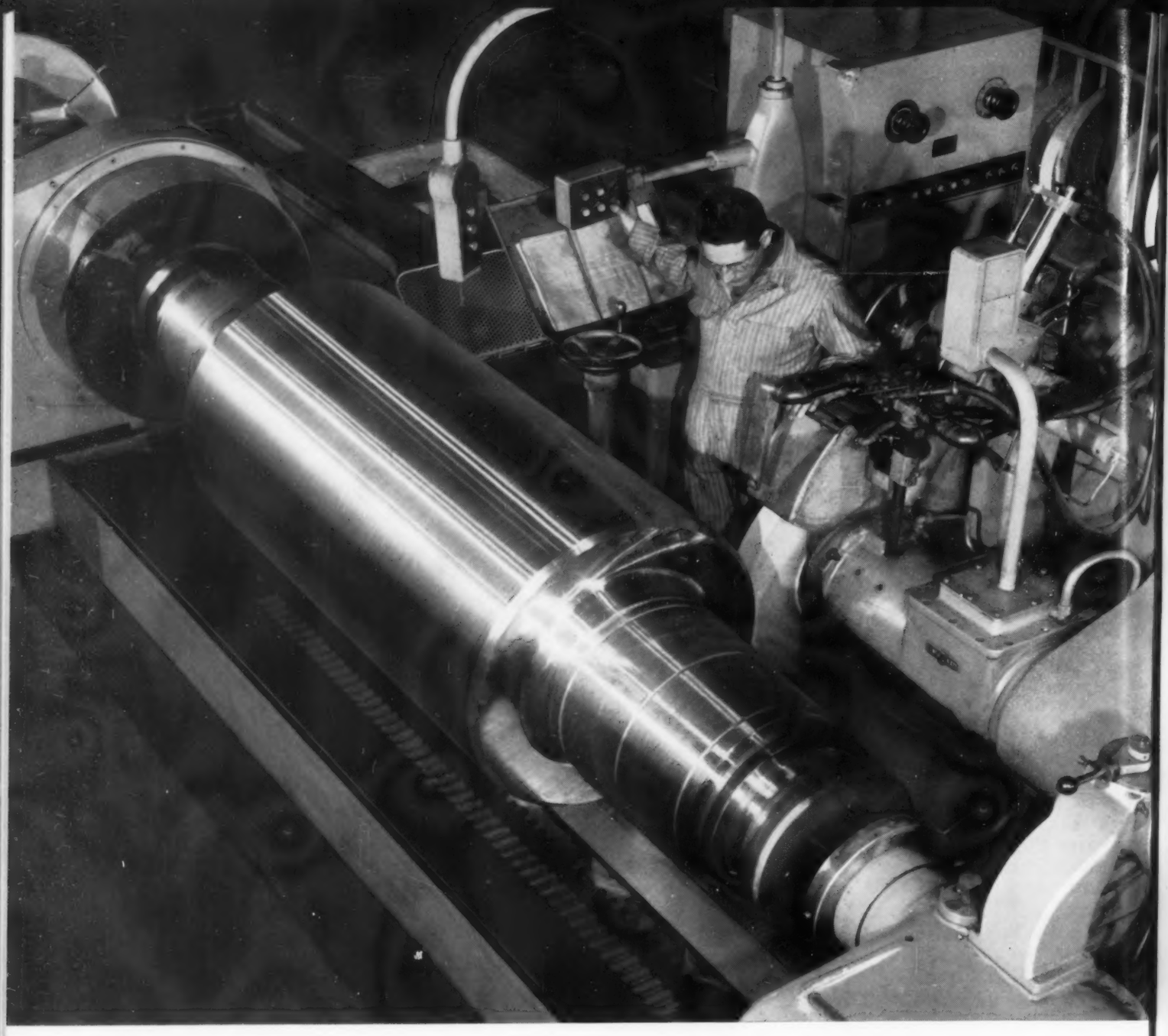


Femco Circuit Scanners may be used for many different control applications. They are low in cost, easy to install with only two wires and are extremely reliable in day in, day out operation.

GET THE FACTS—
ASK A FEMCO SALES ENGINEER

UNderhill 3-3200 **Femco, Inc.** IRWIN, PA.

COMMUNICATION • Electronic Engineers • AUTOMATION



Will be used in rolling aluminum foil

Here's a good example of a medium-sized roll made by Bethlehem to customer specifications. We started with blueprints; melted the steel, forged the ingot, did the necessary preliminary treatment, machined and hardened the forging, and ground it to the specified contours and finish.

This roll weighs approximately 13 tons; has a maximum diameter of 35½ in. and a face of 72 in. Designed for use in the making of aluminum foil, it will serve as a back-up roll in a four-high mill.

We suggest you call us when you need forged, hardened rolls for this and similar kinds of service. Bethlehem is ready to meet any requirements on size, hardness, finish, and other details. Let us quote you whenever your operations involve cold-rolling ferrous sheets and strip . . . running down and finishing copper and brass sheets . . . hot- and cold-rolling aluminum sheets . . . cold-rolling aluminum foil.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

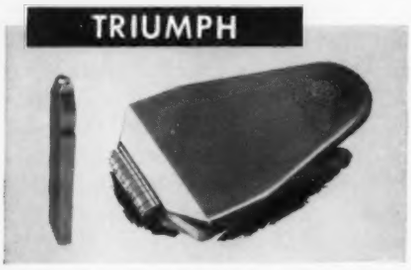
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

X make your mark!

. . . with a Matthews' Holder and interchangeable steel type! For marking versatility . . . for perfect legibility, make your choice Matthews!

TRIUMPH



Simplicity of design and operation are two big features which make this holder ideal for light and medium duty marking. Three sizes are available to hold 3 to 16 pieces of 1/16″ to 3/16″ type characters.

CHAMPION

The "Champion" is recommended for medium heavy or light duty work. Patented spring-clip assembly makes type changes simple. For straight, curved or concave marking . . . 4 to 16 pieces of 1/16″ to 3/8″ type.

RING STYLE

Marking rounds, dials—recessed, concave or convex surfaces? Then, a Matthews' Ring Holder is what you need. Perfect character alignment and spacing—maximum legibility. Type sizes from 1/32″ to 1/4″.

Write today for complete, detailed literature and information.

JAS. H. MATTHEWS & CO.

3958 Forbes Ave., Pittsburgh 13, Pa.

OFFICES IN PRINCIPAL CITIES

WRITE, CALL, OR TWX PG 424

load. The truck is built to load and unload box cars with doors only 7 ft wide.

Also of importance are travel and lift speeds of the truck: top travel speeds exceed 6½ mphr, the fastest of any comparable model. Similarly, lift speeds which range to 31 fpm are also the fastest available.

Other features of the new truck include Elwell-Parker's new "Tri-Safe" braking system which incorporates the safety of three completely independent brakes—dynamic braking, power operated hydraulic wheel brakes, and mechanical armature brake.

All three brakes are actuated by a single toe bar which extends the entire width of the operator's compartment. This, plus dual controls and hydraulic steering makes this new model one of the safest such trucks ever designed, and permits outstanding maneuverability of the truck by an operator from any position in his compartment.

Other features: the mast assembly used on the truck utilizes conventional nested upright design to provide exceptional operator vision and greatly increased maintenance life.

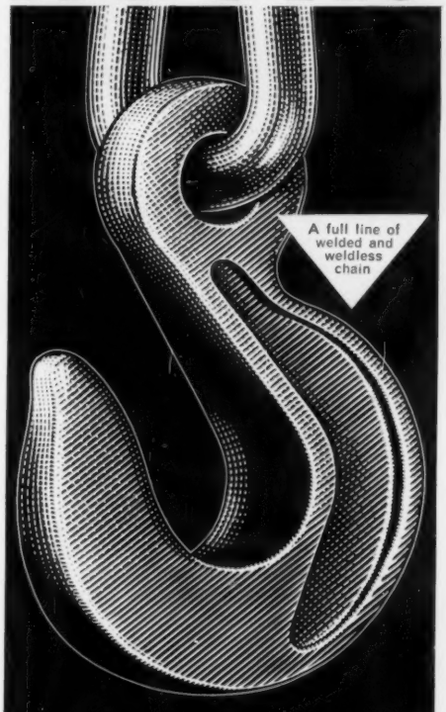
The low silhouette of the truck also provides excellent operator vision in all directions to permit fast, safe handling of the vehicle. The battery compartment is designed to permit removal of the battery by overhead crane, an important convenience to most maintenance departments.

Book Reviews

"The Solid State for Engineers" by Maurice J. Sinnott has been recently published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 521 pages, 6 x 9 in., is cloth bound, and sells for $12.50. This book points out the features of solid materials of special interest to engineers and sets forth a series of fundamental principles to provide an accurate and convenient reference to problems concerning the choice and use of materials. These principles have been developed by a survey of the basic concepts of various sciences bearing on the behavior of the solid state of material. Each of the chapters

PATENTED

TAYCO HOOKS



another advantage of

TM factory-made alloy sling chains!

Pat. No. 2646306

Patented Tayco Hooks are the strongest on the market, for they are drop-forged from special alloy steel with exclusive I-Beam design! Uniform heat-treating, stress-free links, Taylor's quality control and Test Certificate on assembled sling are additional advantages of TM factory-made Alloy Slings. Call your distributor or send for Bulletin 13.

S. G. TAYLOR CHAIN CO., INC.

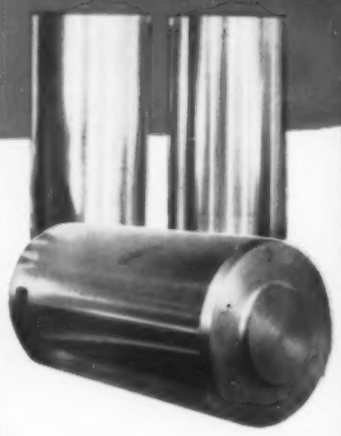
Hammond, Indiana

3505 Smallman St., Pittsburgh, Pa.

Taylor Made CHAIN SINCE 1873

RED CIRCLE Rolls ALLOY-CHILLED

Hyde Park RAMS



for all types of HYDRAULIC EQUIPMENT

Hyde Park Rams are available in Chilled or Alloy Iron.

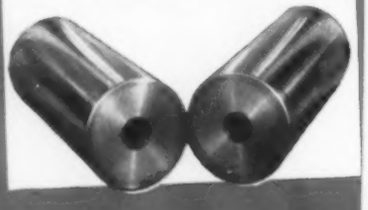
Furnished in hardness range to meet your specification . . . ground to your required size.

On your next replacement of Rams—or for new equipment—consult us. Our engineers will be glad to assist you.

Red Circle Rolls for every Purpose

Rolling Mill Equipment

Gray Iron Castings up to 80,000 lb.



Hyde Park

FOUNDRY & MACHINE CO.

Hyde Park, Westmoreland Co., Pa.

ROLLS

ROLLING MILL MACHINERY

GRAY IRON CASTINGS

represents a condensation of an entire field of investigation; the sciences are discussed in the light of their contributions to the study of material, and problems are interspersed throughout the book to illustrate principles and concept. Examples showing how these principles can be applied to practical problems are included, both in a quantitative fashion and from a qualitative viewpoint. Tables, charts, line drawings and photographs are included to explain and substantiate the text.

"Standard Welding Symbols (A2.0–58)" prepared by AWS Committee on Nomenclature, Definitions and Symbols, approved by Technical Council, has recently been published by the American Welding Society. The publication contains 87 pages, 6 x 9 in., and is bound in heavy paper. This new standard contains many additions and improvements, incorporating the first major change in welding symbols in recent years due to the fact that the number of welding symbols has been doubled because of increased use of welding and the new processes developed and new types of welds adopted. Among the new symbols are: symbols for spot and seam welds made by arc welding; symbols for welds used in aircraft, guided missile and automotive work; and symbols for the types of welds used in structural steel fabrication, reinforced concrete work and the like. A table is included providing a new system for designating welding and cutting processes by means of letters. The system covers the 37 commercially used welding processes and also provides a means for indicating: automatic welding, machine welding, manual welding and semi-automatic welding. The chart of welding symbols has been redesigned to incorporate the new developments, a new arrangement simplifies the recognition of the symbols on the chart. The drawings, diagrams, and text are self-explanatory and what is involved can be seen at a glance. The charts are prepared in two sizes: one for wall use listed at $1.50, a smaller, desk-size replica at 50¢; the booklet is priced at $3.00 and all are available from Department T, American Welding Society, 33

SALI Insulating Bushings

For Electrical Conduit and Boxes

Certainly they cost more!

Why settle for less? The steel mills for twenty-five years have depended on them to safeguard their production life-lines where wires emerge from conduit.

THE Adalet MANUFACTURING COMPANY

14300 LORAIN AVENUE • CLEVELAND 11, OHIO

West 39th Street, New York 18, N. Y.

"Effect of Surface on the Behaviour of Metals," a series of lectures delivered at the Institution of Metallurgist Refresher Course, 1957, has recently been published for The Institution of Metallurgist, by the Philosophical Library, 15 East 40th Street, New York 16, N. Y. The book contains 100 pages, 5½ x 9 in., is cloth bound and sells for $10.00. This volume contains in full the papers read during the 1957 course dealing with the important part which surface plays in influencing the behaviour of metals. The four papers give in concise form a great deal of information, collected from widely scattered sources, about a subject which is still far from being completely understood, but a knowledge of which is becoming increasingly important to physicists, chemists and engineers as well as to metallurgists. The text includes 30 diagrams and 10 pages or art plates.

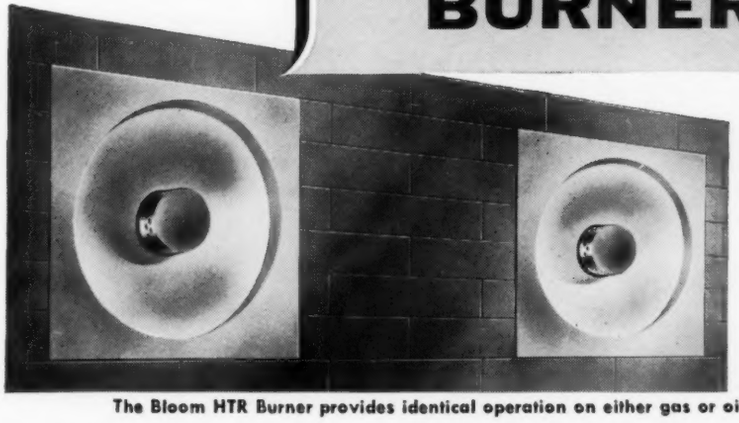
"ASTM Manual on Measurement and Sampling of Petroleum and Petroleum Products," third edition, has recently been published by the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. The book contains 172 pages, 6 x 9 in., is cloth bound, and sells for $3.50. This manual presents under one cover available information for measuring quantities of petroleum and its products, and for obtaining representative samples thereof. It contains the ASTM methods required to measure and compute the quantity of oil in storage and transportation tanks of various types, and for obtaining typical samples of the tank contents.

"NEMA Standard Publication Low - Voltage Power Circuit Breakers," Pub. No. SG 3–1958, September, 1958, has been recently published by the National Electrical Manufacturers Association, 155 East 44th Street, New York 17, N. Y. The standard covers air circuit breakers rated 1500 volts a-c or less and 3000 volts d-c or less and anode circuit breakers. Specific information is given concerning voltage, current and interrupting ratings; temperature rise routine and production tests; application; repetitive duty and normal maintenance; trip devices and settings; accessories; and enclosures. A separate section is devoted to the installation, operation and care of the breakers. The standard which is bound in heavy paper is available from the association, price per copy $3.00.

"Technology of Columbian (Niobium)," edited by E. M. Sherwood and B. W. Gonser, has recently been published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 120 pages, 8½ x 11 in., is cloth bound, and sells for $7.00. The book is a compilation of papers presented at The Symposium on Columbium (Niobium) of The Electrothermics and Metallurgy Division of The Electrochemical Society, May 15 and 16, 1958, Washington, D. C., and is sponsored by the society. Columbium is one of the less common metals which has high strength at elevated temperatures and has much to offer for the designer of structures designed to operate at high temperatures. This compilation presents a rather intensive discussion of the metal, based on past experience as well as on recent and current research efforts, to serve as

for intense concentration of heat...

The BLOOM HTR BURNER



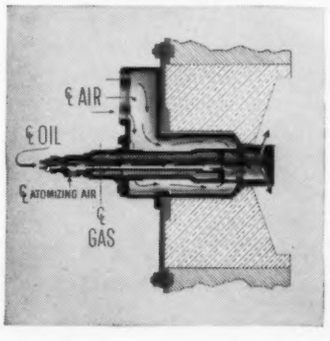
The Bloom HTR Burner provides identical operation on either gas or oil.

This burner enables the engineer to design a heat pattern with excellent results, because it has the unique characteristic of providing localized high heat release with low forward velocity. The burner can be located to fire directly at the material without flame impingement. Roof firing is easily accomplished and provides uniform hearth temperature.

This burner has been very successful in its application to tube upset furnaces; continuous strip annealing, coating, and pre-heating lines; high speed billet heating furnaces; and batch-type forge furnaces.

The Bloom High Thermal Release Burner with its sturdy construction is ideal for applications requiring speed and precision heating.

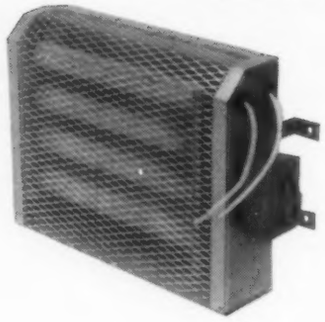
PATENT PENDING



BLOOM ENGINEERING CO., INC.
837 W. North Avenue Pittsburgh 33, Pa.

WALL TYPE

Guyan
HEATERS



FOR CONFINED AREAS

ALSO AVAILABLE IN FLOOR TYPE

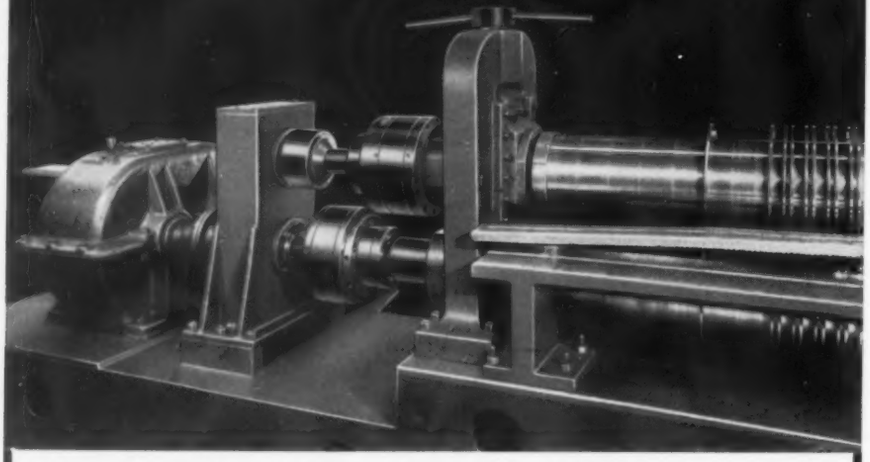
RUGGED
and ECONOMICAL TOO!

WHEN the space is hard to heat — such as a crane or locomotive cab, a pump house or small office — a GUYAN natural convection heater is the answer. It is a DEPENDABLE, LONG-LIFE HEATER consisting of corrosion-resistant aluminum chromium wire — wound on ceramic forms — and mounted within expanded steel housings.
GUYAN Heater Units are ruggedly built to stand the hard service that is customary in tough industrial applications. Available from 1,500 thru 7,500 watts for 110, 220, 440 volts DC or AC. Priced right — more economically than you might think — and lower than you can make your own. Write for complete information.

Guyan
HEATERS

GUYAN MACHINERY CO.
LOGAN, WEST VIRGINIA

for slitter dependability specify
MARLAND ONE-WAY CLUTCHES



Dependable slitter performance is assured by the full-phased, controlled roller action design of Marland One-Way automatic freewheeling clutches. Full-phased roller action permits positive, instantaneous slitter driving or absolute slitter freewheeling for complete protection to the material being processed. For clutches that will give outstanding service and long life on metal slitting, rolling and drawing applications, refer to Marland One-Way Engineering Manual No. 56.

MARLAND ONE-WAY CLUTCH COMPANY
ELM AND WASHINGTON AVES., LA GRANGE, ILLINOIS

a basis for further development work. Papers covering a review of properties, the supply situation, extractive process metallurgy, analysis, effect of gases, alloy studies, and related subjects are included and present a fairly complete coverage of the field.

"The Structure of Steel" (extended and revised), by Edwin Gregory and Eric N. Simons has been recently published by the Philosophical Library, New York, N. Y. The book contains 176 pages, 6 x 8½ in., is cloth bound, and sells for $10.00. The book was first published in 1938, the text has been considerably extended and revised to bring it thoroughly up to date. The book is a simple and as far as possible nontechnical explanation of the metallurgical structure of the various steels and alloys. It shows clearly how the properties of any given steel will depend on composition and treatment during manufacture and both of these aspects are given attention.

"How to Become a Professional Engineer," by John Constance has been recently published by the McGraw-Hill Book Co., 327 W. 41st Street, New York 36, N. Y. The book contains 288 pages, 5⅜ x 8 in., is cloth bound, and sells for $5.50. This is a clear, comprehensive guidebook for both unlicensed engineers-in-practice and young graduates on how to obtain a professional engineer's license. The seven basic requirements for licensure are listed and clarified, various state registration laws are summarized in plain terms; clear examples of how examining boards evaluate the experience of the candidate are shown. How to prepare an application is explained, pointers are given on selecting the qualifying experience and writing it up, how to prepare for written and oral examinations and how to avoid emotional stress during tests are covered, what to anticipate, including pitfalls, in refresher courses is included, and how to achieve multiple-state registration is given. The book is applicable in all states. There is a chapter on the engineer's seal and its use, and extensive appendixes list names and addresses of state board secretaries, accredited schools and recommended texts.

(*Please turn to page 206*)

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SALE
POSITIONS VACANT
POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

WHERE TO BUY

BIRMINGHAM DISTRICT

DIXIE ENGINEERING COMPANY
"Manufacturer's Agents"
812-813 Protective Life Building
BIRMINGHAM 3, ALABAMA
Sabel E. Baum — Telephone 4-0417

CHICAGO DISTRICT

PAUL W. WENDT & SONS
Manhattan Building
CHICAGO 5, ILLINOIS
District Representatives for
A. W. CADMAN MFG. CO.
HUNTER SAW & MACHINE CO.
GRAFO COLLOIDS CORP.

EHRET AND KINSEY
Board of Trade Bldg., 141 West Jackson Blvd.
Chicago 4, Illinois — Wabash 2-0449
Representing
THE CLEVELAND WORM AND GEAR CO.
"Cleveland" Worm Gearing and Worm Gear Speed Reducers—30 Years
THE FARVAL CORPORATION
"Farval" Centralized Lube Systems—30 Years
LUBRICATION PRODUCTS COMPANY
"Strapax" Journal Box Lubricator—24 Years
AMERIGEAR-ZURN, INC.
"Amerigear" Flexible Couplings—9 Years
AMERIGEAR-BLISS SPINDLE COUPLING DIVISION, E. W. BLISS CO.
Spindle Couplings
3904 West Vliet St. — Phone:
Milwaukee 8, Wisc. — Division 2-7844

BERRY BEARING COMPANY
2633 S. Michigan Ave., Chicago 16, Ill.
Phone: DAnube 6-6800
Complete Bearing Service to the Iron and Steel Industry—Since 1920

OHIO DISTRICT

The C. W. THOMSON COMPANY
"Wired Communication Specialists"
- Loudspeaking Communication & Paging
- Battery Operated Portable Equipment

1718 Tytus Avenue — Middletown, Ohio
GArden 2-5441

OHIO (Continued)

The CALVERT Co.
Producers of **Calvert Bus**
- BARE BUS FABRICATION
- CABLE LEADS, Air and liquid cooled
- JUNCTION BOXES, 600 to 23,000 volts
- HIGH AMPERE TERMINALS

ED. 3-1944
19851 Ingersoll Dr., Rocky River 16, O.

PITTSBURGH DISTRICT

W. G. KERR CO., INC.
1005 Liberty Ave. — PITTSBURGH, PA.
Phone: ATlantic 1-4254
Representing:
FOOTE BROS.—Gears and Speed Reducers
REEVES—Variable Speed Drives
THOMAS—Flexible Couplings
WICHITA—Air Tube Disc Clutches & Brakes
TELSMITH—Telsmith Crushers
CULLEN-FRIESTEDT—Sheet Lifters—Welding Positioners—Track Cranes

ELECTRICAL INSTALLATIONS
PATTERSON EMERSON COMSTOCK, INC.
PITTSBURGH, PA.
STEEL MILLS—INDUSTRIALS UTILITIES
313 EAST CARSON ST. — ZONE 19

PITTSBURGH (Continued)

RITTER ENGINEERING CO.
Engineers • Distributors • Contractors
1409 SEDGWICK ST. — Phone:
PITTSBURGH 33, PA. — FAIRFAX 1-8538
TRABON—Centralized Lubricating Systems
METERFLO—Circulating Oil Systems
PARKER—Hydraulic & Fluid System Components
"Specialists in Lubrication and Hydraulics"

ROLLING MILLS and EQUIPMENT
FRANK B. FOSTER, INC.
2220 OLIVER BUILDING PITTSBURGH 22, PA
Cable Address "FOSTER" Pittsburgh

METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
HAZEN ENGINEERING CO.
184 Sandy Creek Road — (Penn Township)
P. O. Box 10597 — PITTSBURGH 35, Pa.
CHurchill 2-1750

CONSULTING ENGINEERS

AUBURN AND ASSOCIATES, INC. ENGINEERS
COMPLETE
ENGINEERING . DESIGN . LAYOUT
FOR
STEEL MILLS AND HEAVY INDUSTRY
923 Penn Ave., Pgh. 22, Pa.
Telephone COurt 1-5014

PATTERSON-EMERSON-COMSTOCK, INC.
Engineering Division
GENERAL ENGINEERING FOR INDUSTRIAL PLANTS
REPORTS—LAYOUTS—DESIGN—ESTIMATES—DETAILS
Specialists In
PRIMARY IRON & STEEL, METALLURGICAL, METAL WORKING INDUSTRIES
AUTOMATION—INDUSTRIAL WASTE & WATER
Birmingham, Ala. — Pittsburgh, Pa. 313 East Carson St. — Warren, Ohio

THE ENGINEERING MART

Consulting Engineers (Continued)

MARTIN J. CONWAY
Consulting Fuel Engineer
111 South Duke Street — Millersville, Pa.
Telephone: TRinity 2-7153
Steel Industry Representative for
CHEMICAL CONSTRUCTION CORPORATION
P-A- VENTURI SCRUBBER
Cleaning Blast Furnace, Converter, Open Hearth and Scarfing Gases. Bulletins Available.

W. VANCE MIDDOUGH & ASSOCIATES
Consulting Electric Engineers
Engineering • Design • Layout
Heavy Industrial Power & Light
Frederick Building — Cleveland 15, Ohio
Prospect 1-2060

ROSS E. BEYNON
Consultant
ROLLING LAYOUT AND ROLL DESIGN
7658 Coles Avenue — Chicago 49, Illinois
Telephone SAginaw 1-3466

HOUSER AND CARAFAS ENGINEERING CO.
Engineering for Industry
4 Smithfield Street — Pittsburgh 22, Pa.
Phone: GRant 1-9929

MACCABEE & ASSOCIATES
Consultants & Design Engineers For The Steel Industry
BEN MACCABEE — 173 W. Madison St. CHICAGO 2, ILLINOIS

JAMESON & ASSOCIATES
CONSULTING ENGINEERS
STEEL MILLS & HEAVY INDUSTRY
ENGINEERING—DESIGN—LAYOUT
173 W. Madison St. — Chicago 2, Ill.
Phone RAndolph 6-9229

Specialists in Electrical
● DESIGN
● LAYOUT
● INSTALLATIONS
VALENTZ ENGINEERING CO.
Engineers & Consultants
611 W. Market — Warren, Ohio
Phone: EXpress 5-0606

IRA E. KING
Consultant
Production Problems in Mill Practice
Specialist in Alloys of Steel
2434 Hay Street — Easton, Pa.
Telephone — Easton 3-3858

PRODUCTS

MODERN MILL OPERATORS' PULPITS
DESIGNED BY WALLACE F. SCHOTT
CONSTRUCTED BY
JAMES CAMPBELL SMITH, INC.
WILLOUGHBY, OHIO

POSITIONS WANTED

POSITION WANTED
Tin Plate Mill
Superintendent or Asst.
AVAILABLE
Box 1201, IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

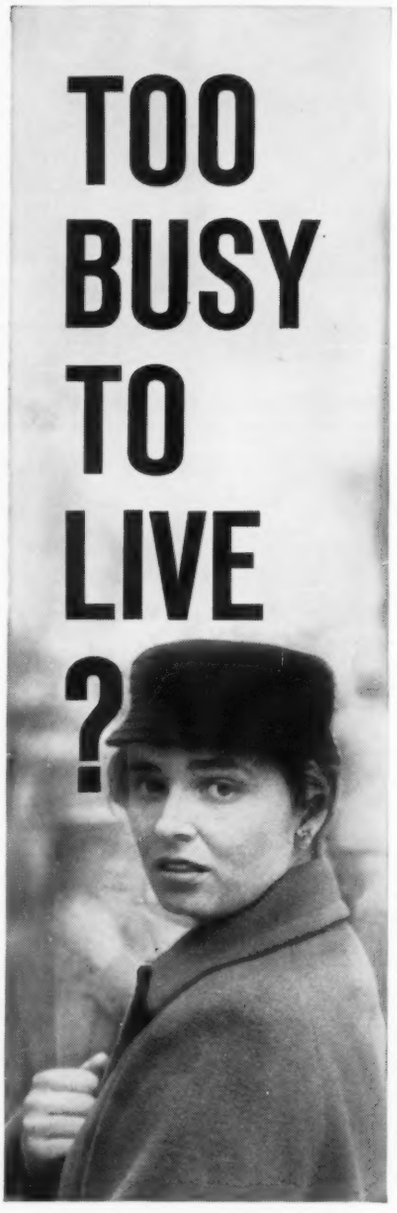
POSITIONS VACANT

ESTIMATOR WANTED
Experienced Heavy Steel Mill Equipment.
Exceptional Opportunity. Apply:
THE AETNA-STANDARD ENGINEERING
14th Floor Frick Bldg., Pittsburgh, Pa.

Book Reviews

(Continued from page 204)

"Brittle Behavior of Engineering Structures," by Earl R. Parker, has recently been published by John Wiley & Sons, Inc., New York, N. Y. The book contains 323 pages, 6 x 9 in., is cloth bound. The book summarizes available information on the brittle behavior of steel in engineering structures. Incorporated are a discussion of the theories and mechanism of failure, a review of test methods used for evaluating relative brittleness, interpretations and summaries of test results, a discussion of the effect of welding composition variations on notch toughness and a report of service failures. Also offered is a valuable survey of the fundamental properties and fracture theories. Numerous illustrations including photographs, line drawings, charts and tables are employed to explain and complete the text.



Are you really too busy to have a health checkup once a year? Or do you put it off because you're afraid your doctor might find something wrong?

If it's cancer you're worried about, remember that doctors are curing many more cancers than they could ten years ago. 800,000 Americans are alive today, cured of cancer... many of them because they had made a habit of having annual checkups no matter how **well** they felt...**all** of them because they went to their doctors **in time!** Make annual checkups a habit ...**for life!**

AMERICAN CANCER SOCIETY

CHRISTMAS SEALS AT WORK!

A most important medical discovery during the past year was a blood test for the detection of tuberculosis.

Developed at Northwestern University under a research grant from the National Tuberculosis Association, it is now undergoing widespread trials. This was made possible by your purchase of Christmas Seals.

Since 1907, the work financed by Christmas Seals has helped cut the TB death rate 95% – but within the next 20 years almost 2,000,000 Americans will be afflicted with tuberculosis. So, send in your contribution today, please.

Buy and use Christmas Seals

This space contributed to the National Tuberculosis Association and its affiliates by

IRON AND STEEL ENGINEER

IRON AND STEEL ENGINEER INDEX FOR 1958

Herewith is presented the index of all authors and papers published in the IRON AND STEEL ENGINEER for the year 1958

LIST OF AUTHORS

A

ACRES, WILLIAM P.—"Choosing the Right Fastener," March, 1958, Page 151.
AKERLOW, EARL V.—"Modifications to the Fontana Open Hearth Precipitators," July, 1958, Page 97.
ANDERSON, E. L.—"Electrical Equipment for a Modern Rod Mill," January, 1958, Page 112.
ANGEL, H. H.—"Protection Against Prolonged Delays on Main Drive Electrical Equipment," April, 1958, Page 77.
ARANT, N. R. and MARSALKA, J. J.—"Relationship Between Scleroscope, Rockwell and Brinell Hardness Readings," February, 1958, Page 160.
AUDETTE, RICHARD R. and LEMMERMAN, RICHARD D.—"Noise—A Problem of Physical and Human Engineering," October, 1958, Page 116.

B

BAILEY, E. T. W.—"Accelerated Firing Rates in Open Hearth Furnaces," October, 1958, Page 124.
BAUER, J. W., JR.—"Proper Installation and Maintenance of Electric Control Systems," April, 1958, Page 128.
BEADLE, R. G. and MILLER, W. E.—Card Programming Control of Rolling Mills—II June, 1958, Page 115.
BEERS, H. S.—"The Forming of Flanged and Dished Heads," May, 1958, Page 110.
BESSENT, C. F.—"Techniques in Rebuilding a Blast Furnace," February, 1958, Page 82.
BESSENT, THOMAS A.—"Recent Lubrication Experiences In The Sparrows Point Plant," December, 1958, Page 117.
BOWERMAN, MYRON R. and MADISON, ELVIN R.—"Standardized Component Parts for Heavy Duty Mill Type Cranes," July, 1958, Page 104.
BRADFORD, J. T. and BROOKS, C. P.—"Recent Advances in Control Systems for Continuous Processing Lines," October, 1958, Page 129.
BROOKS, C. P. and BRADFORD, J. T.—"Recent Advances in Control Systems for Continuous Processing Lines," October, 1958, Page 129.
BYWATER, L. G.—"Coal Chemicals in Industry," October, 1958, Page 101.

C

CALMES, ALBERT, DR. and ROBERTS, CLYDE A.—"Seamless Tube Making By the Calmes Process," February, 1958, Page 124.
CAMPBELL, HENRY W.—"Distributing Raw Materials in Blast Furnaces," April, 1958, Page 116.
CARSON, SAMUEL—"Maintenance of Oil Film Bearings on European Mills," April, 1958, Page 90.
CICHELLI, A. E.—"Mill Gearing as Viewed by a Lubrication Engineer," September, 1958, Page 91.
CLIFFORD, T. D.—"Operational Features of 45-In. Slab Mill and 80-In. Hot Strip Mill at Fairless Works," September, 1958, Page 198.
COOK, J. W., WALLACE, J. W. and WALKER, N. S.—"An Automatic Gage Control System for Tandem Cold Mills," July, 1958, Page 124.
CULVER, E. T. and JOSEPH, JAMES S.—"The Dollars and Sense of Pickle-Liquor Treatment," March, 1958, Page 112.
CURTIS, S. P., SCHRAMM, R. F. and FATH, D. W.—"Automatic Charging Control for No. 3 Fairless Blast Furnace," July, 1958, Page 73.

D

DANIELS, F. C. T. and STASKO, STEVE—"A New Combustion Process for Temperature Uniformity in Heat Treating Furnaces," July, 1958, Page 85.
DATO, J. E.—"Magnetic-Flux Gas Shielded Arc Welding," September, 1958, Page 160.
DAVIS, ERNEST E.—"A Combination Mill for Rolling Rod, Bars and Strip" April, 1958, Page 101.
DIXON, THOMAS E. and KUHNE, HEINZ A.—"Developments in Metallic Recuperators," January, 1958, Page 127.
DRISCOLL, D. H. and RENBERG, CLAIR—"Double Cooling Bed for Rod Mill," March, 1958, Page 141.
DUGAN, JOHN—"Application of Progressive Induction Heating to Forged Roll Hardening Operations," November, 1958, Page 65.

E

EASTON, RUFUS and SKELLEY, H. E.—"Designing a Large Tonnage Continuous Casting Plant," May, 1958, Page 131.
EGGLESTON, R. B., PEEBLES, J. E. and REMLEY, J. J.—"Selection of Electrical Equipment for Temper and Skin Pass Mills," September, 1958, Page 115.
ESS, T. J.—"Republic in the South," April, 1958, Page R-1.
ESS, T. J.—"Weirton Steel Co.," November, 1958, Page W-1.

F

FATH, D. W., CURTIS, S. P. and SCHRAMM, R. F.—"Automatic Charging Control for No. 3 Fairless Blast Furnace," July, 1958, Page 73.
FROSTICK, H. G.—"Trends in Ingot Buggy Design," October, 1958, Page 78.

G

GESDORF, E. J.—"Development and Application of Spray Lubrication," May, 1958, Page 115.
GIFFORD, H. J. and KRAPF, GEORGE H.—"An Operator's Evaluation of the Versatile Gas Turbine," June, 1958, Page 98.
GLEVE, F. J.—"Design of Rolling Mill Slippers," May, 1958, Page 127.
GRAY, A. C. and MITCHELL, J. G.—"Operating and Mechanical Features of New 46 × 100 In. High-Lift Blooming Mill at Stelco" August, 1958, Page 123.
GREINER, JOHN H.—"Recent Hot Strip Mill Roughing Trains," September, 1958, Page 151.
GRIMWOOD, J. E.—"When Do You Change Wire Rope Cables?" June, 1958, Page 94.

H

HANEY, DAVID C.—"Soaking Pits with a High Velocity Combustion System," November, 1958, Page 82.
HARMON, BENJ. G. and PROCTOR, ROBERT V.—"Hydraulic Jet Descaling—A New Method to Remove Scale from Hot Steel," December, 1958, Page 97.
HINDS, G. W. and HODGE, A. L.—"Open Hearth Fuel Atomization With a Reaction-Type Jet Burner," December, 1958, Page 88.
HODGE, A. L.—"The Oxidation Mechanism in the Open Hearth Furnace," November, 1958, Page 97.
HODGE, A. L. and HINDS, G. W.—"Open Hearth Fuel Atomization With a Reaction-Type Jet Burner," December, 1958, Page 88.
HOFFMANN, OTTO and KRYNYTZKY, ALEX—"A Modern Forging Press and Its Controls," June, 1958, Page 81.
HOLBROOK, D. S.—"The Growing Canadian Steel Industry," July, 1958, Page 133.
HOLMAN, ROBERT W.—"Card Programming Control of Rolling Mills—I," June, 1958, Page 113.
HOWRY, A. D.—"Measuring the Investment Worth of Capital Expenditure Proposals," December, 1958, Page 79.
HUSTON, C. L., JR.—"Progress—Past and Future," August, 1958, Page 69.
HYAMS, WILLIAM—"Automatic Contour Turning of Large Mill Rolls," March, 1958, Page 82.

J

JOSEPH, JAMES S. and CULVER, E. T.—"The Dollars and Sense of Pickle-Liquor Treatment," March, 1958, Page 112.

K

KALBERKAMP, H. J.—"Recent Developments in Slabbing Mills," February, 1958, Page 73.
KELLER, J. D.—"Fast Annealing of Sheet-Strip Coils with Helium Injection," April, 1958, Page 109.
KENNEDY, G. E. and SLAMAR, F.—"Turn-Up and Turn-Down in Hot Rolling," March, 1958, Page 71.
KENNEDY, JAMES R.—"Planned Maintenance Techniques for a Hot Strip Mill," October, 1958, Page 139.
KENYON, A. F. and OAKES, H. J.—"Electrical Drive System For a High Speed Combination Rod Mill," March, 1958, Page 123.
KERN, EMIL and TRABITS, JAMES E.—"Allegheny Ludlum Steel Corp.'s New Forge Shop, Dunkirk, N. Y.," June, 1958, Page 73.
KINNEY, JOHN E.—"Stream Pollution Reflects Operating Practices," April, 1958, Page 97.
KIRKDOFFER, N. R.—"Benefits of Purchased Oxygen to the Indiana Harbor Works of the Inland Steel Company," May, 1958, Page 71.
KITT, HOWARD G. and WORLEY, ROBERT W.—"Trends in Steel Mill Power Plants," March, 1958, Page 90.
KRAPF, GEORGE H. and GIFFORD, H. J.—"An Operator's Evaluation of the Versatile Gas Turbine," June, 1958, Page 98.
KRAPF, G. H. and STEPHENS, J. O.—"Gas Turbines for Blast Furnace Blowing," September, 1958, Page 142.
KRYNYTZKY, ALEX and HOFFMANN, OTTO—"A Modern Forging Press and Its Controls," June, 1958, Page 81.
KUHNE, HEINZ A. and DIXON, THOMAS E.—"Developments in Metallic Recuperators," January, 1958, Page 127.
KUKA, K. S.—"Standardization of Steel Mill Crane Control Systems," December, 1958, Page 61.
KYLE, ROBERT—"Gas Storage for Peak Demands," August, 1958, Page 109.

L

LAMBERT, R. A.—"Economics of Generated vs Purchased Oxygen for Steel Plant Use," May, 1958, Page 76.
LEMMERMAN, RICHARD D. and AUDETTE, RICHARD R.—"Noise—A Problem of Physical and Human Engineering," October, 1958, Page 116.
LEWIS, W. E.—"Electric Furnace Steel Manufacturing," March, 1958, Page 98.
LEWIS, W. M.—"Maintenance of Backup Roll Bearings in Strip Mills," November, 1958, Page 115.
LINDBERG, JEROME L.—"It Ain't Mechanical," September, 1958, Page 166.

M

McLEAN, WILLIAM B.—"Structural Design Problems and Recommended Practice for Ore Bridges and Unloaders," August, 1958, Page 78.
McLEOD, ALASTAIR—"European Steelmaking Today," February, 1958, Page 133.
McMICHAEL, R. C.—"A Review of European Steel Plant Progress—1957," August, 1958, Page 73.
McQUAID, HARRY W.—"The Direct Reduction of Iron Ore in the United States," January, 1958, Page 69.
MACQUEEN, A. J. F.—"Factors in the Design of a Steel Plant Power System," October, 1958, Page 92.
MADISON, ELVIN R. and BOWERMAN, MYRON R.—"Standardized Component Parts for Heavy Duty Mill Type Cranes," July, 1958, Page 104.
MADSEN, I. E.—"Developments in the Iron and Steel Industry During 1957," January, 1958, Page 139.
MADSEN, I. E.—"Coke and By-Products In 1957," December, 1958, Page 73.
MAGIE, WM. A., 2ND—"Importance of Pumpability and Heat Stability in Industrial Greases," October, 1958, Page 87.
MARSALKA, J. J. and ARANT, N. R.—"Relationship Between Scleroscope, Rockwell and Brinell Hardness Readings," February, 1958, Page 160.
MICHELS, N. C.—"Tomorrow's Engineer," June, 1958, Page 104.
MILLER, W. E. and BEADLE, R. G.—"Card Programming Control of Rolling Mills," June, 1958, Page 115.
MITCHELL, HOWARD L.—"Installation of Stretch Reducing Mill," March, 1958, Page 139.
MITCHELL, J. G. and GRAY, A. C.—"Operating and Mechanical Features of New 46 × 100 In. High-Lift Blooming Mill at Stelco," August, 1958, Page 123.
MORAN, R. J.—"The Application of Silicon and Germanium Power Rectifiers in the Steel Industry," August, 1958, Page 117.
MOSSO, A. J.—"Power Layouts in Steel Mills," February, 1958, Page 111.

O

OAKES, H. J. and KENYON, A. F.—"Electrical Drive System For a High Speed Combination Rod Mill," March, 1958, Page 123.
ORELLANA, I. G.—"Development of Automatic Thickness Controls for Strip Mills," March, 1958, Page 144.

P

PARTRIDGE, EVERETT P. and PAULSON, E. G.—"Tackling Water Pollution," November, 1958, Page 123.
PATTON, A. D. and SMITH R. A.—"Some Practical Solutions to Hot Mill Problems," July, 1958, Page 92.
PAULSON, E. G. and PARTRIDGE, EVERETT P.—"Tackling Water Pollution," November, 1958, Page 123.
PEEBLES, J. E., REMLEY, J. J. and EGGLESTON, R. B.—"Selection of Electrical Equipment for Temper and Skin Pass Mills," September, 1958, Page 115.
PHILIPP, HOWARD D.—"Development of Atomic Power and its Possible Applications to the Steel Industry," December, 1958, Page 109.
PHILLIPS, R. A.—"Methods of Control of Strip Dimensions on Hot Strip Finishing Mills," May, 1958, Page 100.
POLACK, S. P.—"Progress in Developing Fire-Resistant Hydraulic Fluids," August, 1958, Page 87.
PROCTOR, ROBERT V. and HARMON, BENJ. G.—"Hydraulic Jet Descaling—A New Method to Remove Scale from Hot Steel," December, 1958, Page 97.

R

REMLEY, J. J., EGGLESTON, R. B. and PEEBLES, J. E.—"Selection of Electrical Equipment for Temper and Skin Pass Mills," September, 1958, Page 115.
RENBERG, CLAIR and DRISCOLL, D. H.—"Double Cooling Bed for Rod Mill," March, 1958, Page 141.
ROBERTS, CLYDE A. and CALMES, ALBERT, DR.—"Seamless Tube Making By the Calmes Process," February, 1958, Page 124.
ROLDAN, ING. PASCUAL GUTIERREZ—"The Steel Industry of Mexico—Its Present and Immediate Future," January, 1958, Page 80.
RUSSELL, R. M. L.—"Safeguarding Steel Production," July, 1958, Page 112.

S

SACKERSON, GEORGE—"Primary Roll Neck Bearings and their Protection," February, 1958, Page 102.
SAUSSAMAN, J. D.—"Blast Furnace Operation with Western Raw Materials," November, 1958, Page 77.
SAVELAND, WALTER T., JR.—"Shaft Alinement and What It Means," September, 1958, Page 103.
SAVELAND, WALTER T., JR.—"Large Motor Bearings," October, 1958, Page 107.
SCHILLING, CLARENCE J.—"Oxygen Plant Cycles Tailored to Requirements of Iron and Steel Producers," May, 1958, Page 86.
SCHOEN, F. C.—"Light Weight Ladle Crane Trolleys Allow Larger Open Hearth Heats," September, 1958, Page 107.
SCHRAMM R. F., FATH, D. W. and CURTIS, S. P.—"Automatic Charging Control for No. 3 Fairless Blast Furnace," July, 1958, Page 73.
SCHWABE, W. E.—"Lighting Flicker Caused by Electric Arc Furnaces," August, 1958, Page 93.
SENDZIMIR, T.—"The Planetary Mill and Its Uses," January, 1958, Page 95.
SEVERSON, R. J.—"Material of Rolling Mill Slippers," May, 1958, Page 129.
SILLS, R. M. and TERWILLIGER, G. E.—"Automatic Numerical Data Logging and Processing in the Steel Industry," November, 1958, Page 101.
SIMMERS, CHARLES F.—"500-Ton Hot Metal Ladle Crane," December, 1958, Page 124.
SKELLEY, H. E. and EASTON, RUFUS—"Designing a Large Tonnage Continuous Casting Plant," May, 1958, Page 131.
SLABY, EUGENE R.—"Rustproofing Oils for Processing," January, 1958, Page 102.
SLAMAR, F. and KENNEDY, G. E.—"Turn-up and Turn-Down in Hot Rolling," March, 1958, Page 71.
SMITH, R. A. and PATTON, A. D.—"Some Practical Solutions to Hot Mill Problems," July, 1958, Page 92.
STASKO, STEVE and DANIELS, F. C. T.—"A New Combustion Process for Temperature Uniformity in Heat Treating Furnaces," July, 1958, Page 85.
STEPHENS, J. O. and KRAPF, G. H.—"Gas Turbines for Blast Furnace Blowing," September, 1958, Page 142.
STOKER, A. B.—"Railroad Car Rebuilds and Repair at Kaiser's Fontana Works," August, 1958, Page 132.
STRASSBURGER, J. H.—"Summary of Operating Results," May, 1958, Page 69.
STUTZER, A.—"Maintenance Experience with Oxygen Plants at Sparrows Point," May, 1958, Page 84.
SUMRALL, MELVIN—"Production of Seamless Casing and Tubing," March, 1958, Page 138.

T

TERWILLIGER, G. E. and SILLS, R. M.—"Automatic Numerical Data Logging and Processing in the Steel Industry," November 1958, Page 101.

TESKEY, G. W., JR.—"Carbon Black in Fuel Oil for Open Hearth Furnaces," October, 1958, Page 71.
TOROK, LOUIS—"Recent Innovations in Blast Furnace Maintenance and Rebuilding," September, 1958, Page 173.
TRABITS, JAMES E. and KERN, EMIL—"Allegheny Ludlum Steel Corp.'s New Forge Shop, Dunkirk, N. Y.," June, 1958, Page 73.
TUCKER, F. E.—"Ventilation of Large Industrial Buildings Under Heat Load," June, 1958, Page 107.
TUNNY, W. J.—"Dual Bridge Drives for Overhead Traveling Cranes," April, 1958, Page 125.

V

VONADA, E. E.—"Electrical Advances Can Reduce Installed Costs," November, 1958, Page 90.

W

Walker, N. S., COOK, J. W. and WALLACE, J. W.—"An Automatic Gage Control System for Tandem Cold Mills," July, 1958, Page 124.
WALKER, P. F.—"Structural Steel Handling with Mobile Equipment," November, 1958, Page 110.
WALLACE, J. W., WALKER, N. S. and COOK, J. W.—"An Automatic Gage Control System for Tandem Cold Mills," July, 1958, Page 124.
WORLEY, ROBERT W. and KITT, HOWARD G.—"Trends in Steel Mill Power Plants," March, 1958, Page 90.
WRIGHT, G. T.—"Operations and Maintenance of a 100-ton Double-Cycle, Gaseous Oxygen Plant," May, 1958, Page 81.

Y

YARD, EDWARD M.—"High Velocity Gas Stress-Relieving Furnace," February, 1958, Page 95.
YARHOUSE, WALTER T.—"Ten Painting Reminders for Steel Plants," September, 1958, Page 129.

LIST OF SUBJECTS

A

"AISE Annual Convention and Exposition—Pictorial Review"—October, 1958, Page 136.
"AISE District Chairmen—1957–1958"—March, 1958, Page 80.
"AISE Kelly Award Winners"—October, 1958, Page 138.
"AISE National Committees, 1958"—January, 1958, Page 93.
"AISE Officers and Directors, 1958"—January, 1958, Page 90.
"AISE Standard No. 8, Crane and Mill Auxiliary Drive Motor Cable Size Wiring Standards"—December, 1958, Page 132.
"Accelerated Firing Rates in Open Hearth Furnaces"—By E. T. W. BAILEY, October, 1958, Page 124.
"Allegheny Ludlum Steel Corp's New Forge Shop, Dunkirk, N. Y."—By EMIL KERN and JAMES E. TRABITS, June, 1958, Page 73.
"Annealing of Sheet-Strip Coils with Helium Injection, Fast"—By J. D. Kelser, April, 1958, Page 109.
"Application of Progressive Induction Heating to Forged Roll Hardening Operations"—By JOHN DUGAN, November, 1958, Page 65.
"Application of Silicon and Germanium Power Rectifiers in the Steel Industry"—By R. J. MORAN, August, 1958, Page 117.
"Arc Furnaces, Lighting Flicker Caused by Electric"—By W. E. SCHWABE, August, 1958, Page 93.
"Atomic Power and its Possible Applications to the Steel Industry, Development of"—By HOWARD D. PHILIPP, December, 1958, Page 109.
"Atomization With a Reaction-Type Jet Burner, Open Hearth Fuel"—By A. L. HODGE and G. W. HINDS, December, 1958, Page 88.
"Automatic Charging Control for No. 3 Fairless Blast Furnace"—By S. P. CURTIS, R. F. SCHRAMM and D. W. FATH, July, 1958, Page 73.
"Automatic Contour Turning of Large Mill Rolls"—By WILLIAM HYAMS, March, 1958, Page 82.
"Automatic Gage Control System for Tanden Cold Mills, An"—By N. S. WALKER, J. W. COOK and J. W. WALLACE, July, 1958, Page 124.
"Automatic Numerical Data Logging and Processing in the Steel Industry"—By R. M. SILLS and G. E. TERWILLIGER, November, 1958, Page 101.

B

"Bars and Strip, A Combination Mill for Rolling Rod"—By ERNEST E. DAVIS, April, 1958, Page 101.
"Bearings and their Protection, Primary Roll Neck"—By GEORGE SACKERSON, February, 1958, Page 102.
"Bearings in Strip Mills, Maintenance of Backup Roll"—By W. M. LEWIS, November, 1958, Page 115.
"Bearings, Large Motor"—By WALTER T. SAVELAND, JR., October, 1958, Page 107.
"Bearings on European Mills, Maintenance of Oil Film"—By SAMUEL CARSON, April, 1958, Page 90.
"Benefits of Purchased Oxygen to the Indiana Harbor Works of the Inland Steel Company"—By N. R. KIRKDOFFER, May, 1958, Page 71.
"Blast Furnace, Automatic Charging Control for No. 3 Fairless"—By S. P. CURTIS, R. F. SCHRAMM and D. W. FATH, July, 1958, Page 73.
"Blast Furnace Blowing, Gas Turbines for"—By G. H. KRAPF and J. O. STEPHENS, September, 1958, Page 142.
"Blast Furnace Maintenance and Rebuilding, Recent Innovations in"—By LOUIS TOROK, September, 1958, Page 173.
"Blast Furnace Operation with Western Raw Materials"—By J. D. SAUSSAMAN, November, 1958, Page 77.
"Blast Furnace, Techniques in Rebuilding a"—By C. F. BESSENT, February, 1958, Page 82.
"Blast Furnaces, Distributing Raw Materials in"—By HENRY W. CAMPBELL, April, 1958, Page 116.
"Blooming Mill at Stelco, Operating and Mechanical Features of New 46 × 100 In. High-Lift"—By A. C. GRAY and J. G. MITCHELL, August, 1958, Page 123.
"Blowing, Gas Turbines for Blast Furnace"—By G. H. KRAPF and J. O. STEPHENS, September, 1958, Page 142.
"Bridges and Unloaders, Structural Design Problems and Recommended Practice for Ore"—By WILLIAM B. McLEAN, August, 1958, Page 78.
"Buildings Under Heat Load, Ventilation of Large Industrial"—By F. E. TUCKER, June, 1958, Page 107.
"Burner, Open Hearth Fuel Atomization With a Reaction-Type Jet"—By A. L. HODGE and G. W. HINDS, December, 1958, Page 88.

C

"Cables?, When Do You Change Wire Rope"—By J. E. GRIMWOOD, June, 1958, Page 94.
"Calmes Process, Seamless Tube Making by the"—By DR. ALBERT CALMES and CLYDE A. ROBERTS, February, 1958, Page 124.
"Canadian Steel Industry, The Growing"—By D. S. HOLBROOK, July, 1958, Page 133.
"Capital Expenditure Proposals, Measuring the Investment Worth of"—By A. D. HOWRY, December, 1958, Page 79.
"Carbon Black in Fuel Oil for Open Hearth Furnaces"—By G. W. TESKEY, JR., October, 1958, Page 71.
"Card Programming Control of Rolling Mills—I"—By ROBERT W. HOLMAN, June, 1958, Page 113.
"Card Programming Control of Rolling Mills—II"—By R. G. BEADLE and W. E. MILLER, June, 1958, Page 115.
"Casting Plant, Designing a Large Tonnage Continuous"—By H. E. SKELLEY and RUFUS EASTON, May, 1958, Page 131.
"Chairmen—1957–1958, AISE District"—March, 1958, Page 80.
"Chemicals in Industry, Coal"—By L. G. BYWATER, October, 1958, Page 101.
"Choosing the Right Fastener"—By WILLIAM P. ACRES, March, 1958, Page 151.
"Coal Chemicals in Industry"—By L. G. BYWATER, October, 1958, Page 101.
"Coke and By-Products In 1957"—By I. E. MADSEN, December, 1958, Page 73.
"Combination Mill for Rolling Rod, Bars and Strip, A"—By ERNEST E. DAVIS, April, 1958, Page 101.
"Combustion Process for Temperature Uniformity in Heat Treating Furnaces, A New"—By F. C. T. DANIELS and STEVE STASKO, July, 1958, Page 85.
"Combustion System, Soaking Pits with a High Velocity"—By DAVID C. HANEY, November, 1958, Page 82.
"Continuous Casting Plant, Designing a Large Tonnage"—By H. E. SKELLEY and RUFUS EASTON, May, 1958, Page 131.
"Control Systems for Continuous Processing Lines, Recent Advances in"—By C. P. BROOKS and J. T. BRADFORD, October, 1958, Page 129.
"Control Systems, Proper Installation and Maintenance of Electric"—By J. W. BAUER, JR., April, 1958, Page 128.
"Control Systems, Standardization of Steel Mill Crane"—By K. S. KUKA, December, 1958, Page 61.
"Convention and Exposition—Pictorial Review, AISE Annual"—October, 1958, Page 136.
"Convention and Exposition, Program—1958 AISE Annual"—August, 1958, Page 101.
"Convention and Iron and Steel Exposition, Program—1958 AISE Annual"—September, 1958, Page 176.
"Cooling Bed for Rod Mill, Double"—By D. H. DRISCOLL and CLAIR RENBERG, March, 1958, Page 141.
"Crane and Mill Auxiliary Drive Motor Cable Size Wiring Standards, AISE Standard No. 8"—December, 1958, Page 132.
"Crane Control Systems, Standardization of Steel Mill"—By K. S. KUKA, December, 1958, Page 61.
"Crane, 500-Ton Hot Metal Ladle"—By CHARLES F. SIMMERS, December, 1958, Page 124.
"Crane Trolleys Allow Larger Open Hearth Heats, Light Weight Ladle"—By F. C. SCHOEN, September, 1958, Page 107.
"Cranes, Dual Bridge Drives for Overhead Traveling"—By W. J. TUNNY, April, 1958, Page 125.

"Cranes, Standardized Component Parts for Heavy Duty Mill Type"—By MYRON R. BOWERMAN and ELVIN R. MADISON, July, 1958, Page 104.

D

"Descaling—A New Method to Remove Scale from Hot Steel, Hydraulic Jet"—By BENJ. G. HARMON and ROBERT V. PROCTOR, December, 1958, Page 97.
"Design of Rolling Mill Slippers"—By F. J. GLEVE, May, 1958, Page 127.
"Designing a Large Tonnage Continuous Casting Plant"—By H. E. SKELLEY and RUFUS EASTON, May, 1958, Page 131.
"Development and Application of Spray Lubrication"—By E. J. GESDORF, May, 1958, Page 115.
"Development of Atomic Power and its Possible Applications to the Steel Industry"—By HOWARD D. PHILIPP, December, 1958, Page 109.
"Development of Automatic Thickness Controls for Strip Mills"—By I. G. ORELLANA, March, 1958, Page 144.
"Developments in the Iron and Steel Industry During 1957"—By I. E. MADSEN, January, 1958, Page 139.
"Developments in Metallic Recuperators"—By THOMAS E. DIXON and HEINZ A. KUHNE, January, 1958, Page 127.
"Direct Reduction of Iron Ore in the United States, The"—By HARRY W. McQUAID, January, 1958, Page 69.
"Dished Heads, The Forming of Flanged and"—By H. S. BEERS, May, 1958, Page 110.
"Distributing Raw Materials in Blast Furnaces"—By HENRY W. CAMPBELL, April, 1958, Page 116.
"Dollars and Sense of Pickle-Liquor Treatment, The"—By JAMES S. JOSEPH and E. T. CULVER, March, 1958, Page 112.
"Double Cooling Bed for Rod Mill"—By D. H. DRISCOLL and CLAIR RENBERG, March, 1958, Page 141.
"Drive Electrical Equipment, Protection Against Prolonged Delays on Main"—By H. H. ANGEL, April, 1958, Page 77.
"Dual Bridge Drives for Overhead Traveling Cranes"—By W. J. TUNNY, April, 1958, Page 125.

E

"Economics of Generated vs Purchased Oxygen for Steel Plant Use"—By R. A. LAMBERT, May, 1958, Page 76.
"Electric Furnace Steel Manufacturing"—By W. E. LEWIS, March, 1958, Page 98.
"Electrical Advances Can Reduce Installed Costs"—By E. E. VONADA, November, 1958, Page 90.
"Electrical Drive System For a High Speed Combination Rod Mill"—By A. F. KENYON and H. J. OAKES, March, 1958, Page 123.
"Electrical Equipment for a Modern Rod Mill"—By E. L. ANDERSON, January, 1958, Page 112.
"Electrical Equipment, Protection Against Prolonged Delays on Main Drive"—By H. H. ANGEL, April, 1958, Page 77.
"European Steelmaking Today"—By ALASTAIR McLEOD, February, 1958, Page 133.
"European Steel Plant Progress—1957, A Review of"— By R. C. McMICHAEL, August, 1958, Page 73.
"Exposition—Pictorial Review, AISE Annual Convention and"—October, 1958, Page 136.

F

"Factors in the Design of a Steel Plant Power System"—By A. J. F. MACQUEEN, October, 1958, Page 92.
"Fairless Blast Furnace, Automatic Charging Control for No. 3"—By S. P. CURTIS, R. F. SCHRAMM and D. W. FATH, July, 1958, Page 73.
"Fairless Works, Operational Features of 45-In. Slab Mill and 80-In. Hot Strip Mill at"—By T. D. CLIFFORD, September, 1958, Page 198.
"Fast Annealing of Sheet-Strip Coils with Helium Injection"—By J. D. KELLER, April, 1958, Page 109.
"Fastener, Choosing the Right"—By WILLIAM P. ACRES, March, 1958, Page 151.
"Firing Rates in Open Hearth Furnaces, Accelerated"—By E. T. W. BAILEY, October, 1958, Page 124.
"Flanged and Dished Heads, The Forming of"—By H. S. BEERS, May, 1958, Page 110.
"Fontana Open Hearth Precipitators, Modifications to the"—By EARL V. AKERLOW, July, 1958, Page 97.
"Forge Shop, Dunkirk, N. Y., Allegheny Ludlum Steel Corp's New"—By EMIL KERN and JAMES E. TRABITS, June, 1958, Page 73.
"Forging Press and Its Control, A Modern"—By OTTO HOFFMANN and ALEX KRYNYTZKY, June, 1958, Page 81.
"Forming of Flanged and Dished Heads, The"—By H. S. BEERS, May, 1958, Page 110.
"Furnace, High Velocity Gas Stress-Relieving"—By EDWARD M. YARD, February, 1958, Page 95.
"Furnace Operation with Western Raw Materials, Blast"—By J. D. SAUSSAMAN, November, 1958, Page 77.

G

"Gage Control System for Tandem Cold Mills, An Automatic"—By N. S. WALKER, J. W. COOK and J. W. WALLACE, July, 1958, Page 124.
"Gas Storage for Peak Demands"—By ROBERT KYLE, August, 1958, Page 109.
"Gas Turbine, An Operator's Evaluation of the Versatile"—By GEORGE H. KRAPF and H. J. GIFFORD, June, 1958, Page 98.
"Gas Turbines for Blast Furnace Blowing"—By G. H. KRAPF and J. O. STEPHENS, September, 1958, Page 142.
"Gearing as Viewed by a Lubrication Engineer, Mill"—By A. E. CICHELLI, September, 1958, Page 91.
"Germanium Power Rectifiers in the Steel Industry, The Application of Silicon and"—By R. J. MORAN, August, 1958, Page 117.
"Greases, Importance of Pumpability and Heat Stability in Industrial"—By WM. A. MAGIE, 2ND, October, 1958, Page 87.
"Growing Canadian Steel Industry, The"—By D. S. HOLBROOK, July, 1958, Page 133.

H

"Hardness Readings, Relationship Between Scleroscope, Rockwell and Brinell"—By N. R. ARANT and J. J. MARSALKA, February, 1958, Page 160.
"Heat Treating Furnaces, A New Combustion Process for Temperature Uniformity in"—By F. C. T. DANIELS and STEVE STASKO, July, 1958, Page 85.
"Helium Injection, Fast Annealing of Sheet-Strip Coils with"—By J. D. KELLER, April, 1958, Page 109.
"High Velocity Gas Stress-Relieving Furnace"—By EDWARD M. YARD, February, 1958, Page 95.
"Hot Mill Problems, Some Practical Solutions to"—By R. A. SMITH and A. D. PATTON, July, 1958, Page 92.
"Hot Rolling, Turn-Up and Turn-Down in"—By G. E. KENNEDY and F. SLAMAR, March, 1958, Page 71.
"Hydraulic Fluids, Progress in Developing Fire-Resistant"—By S. P. POLACK, August, 1958, Page 87.
"Hydraulic Jet Descaling—A New Method to Remove Scale from Hot Steel"—By BENJ. G. HARMON and ROBERT V. PROCTOR, December, 1958, Page 97.

I

"Importance of Pumpability and Heat Stability in Industrial Greases"—By WM. A. MAGIE, 2ND, October, 1958, Page 87.
"Induction Heating to Forged Roll Hardening Operations, Application of Progressive"—By JOHN DUGAN, November, 1958, Page 65.
"Ingot Buggy Design, Trends in"—By H. G. FROSTICK, October, 1958, Page 78.
"Inland Steel Company, Benefits of Purchased Oxygen to the Indiana Harbor Works of the"—By N. R. KIRKDOFFER, May, 1958, Page 71.
"Installation of Stretch Reducing Mill"—By HOWARD L. MITCHELL, March, 1958, Page 139.
"Iron and Steel Industry During 1957, Developments in the"—By I. E. MADSEN, January, 1958, Page 139.
"It Ain't Mechanical"—By JEROME L. LINDBERG, September, 1958, Page 166.

K

"Kaiser's Fontana Works, Railroad Car Rebuilds and Repair at"—By A. B. STOKER, August, 1958, Page 132.

L

"Ladle Crane, 500-Ton Hot Metal"—By CHARLES F. SIMMERS, December, 1958, Page 124.
"Large Motor Bearings"—By WALTER T. SAVELAND, JR., October, 1958, Page 107.
"Light Weight Ladle Crane Trolleys Allow Larger Open Hearth Heats"—By F. C. SCHOEN, September, 1958, Page 107.
"Lighting Flicker Caused by Electric Arc Furnaces"—By W. E. SCHWABE, August, 1958, Page 93.
"Logging and Processing in the Steel Industry, Automatic Numerical Data"—By R. M. SILLS and G. E. TERWILLIGER, November, 1958, Page 101.
"Lubrication, Development and Application of Spray"—By E. J. GESDORF, May, 1958, Page 115.
"Lubrication Experiences in the Sparrows Point Plant, Recent"—By THOMAS A. BESSENT, December, 1958, Page 117.

M

"Magnetic-Flux Gas Shielded Arc Welding"—By J. E. DATO, September, 1958, Page 160.
"Maintenance Experience with Oxygen Plants at Sparrows Point"—By A. STUTZER, May, 1958, Page 84.
"Maintenance of Backup Roll Bearings in Strip Mills"—By W. M. LEWIS, November, 1958, Page 115.

"Maintenance of Oil Film Bearings on European Mills"—By SAMUEL CARSON, April, 1958, Page 90.
"Material of Rolling Mill Slippers"—By R. J. SEVERSON, May, 1958, Page 129.
"Materials, Blast Furnace Operation with Western Raw"—By J. D. SAUSSAMAN, November, 1958, Page 77.
"Measuring The Investment Worth of Capital Expenditure Proposals"—A. D. HOWRY, December, 1958, Page 79.
"Metallic Recuperators, Developments in"—By THOMAS E. DIXON and HEINZ A. KUHNE, January, 1958, Page 127.
"Methods of Control of Strip Dimensions on Hot Strip Finishing Mills"—By R. A. PHILLIPS, May, 1958, Page 100.
"Mexico—Its Present and Immediate Future, The Steel Industry of"—By ING. PASCUAL GUTIERREZ ROLDAN, January, 1958, Page 80.
"Mill Gearing as Viewed by a Lubrication Engineer"—By A. E. CICHELLI, September, 1958, Page 91.
"Mobile Equipment, Structural Steel Handling with"—By P. F. WALKER, November, 1958, Page 110.
"Modern Forging Press and Its Control"—By OTTO HOFFMANN and ALEX KRYNYTZKY, June, 1958, Page 81.
'Modifications to the Fontana Open Hearth Precipitators"—By EARL V. AKERLOW, July 1958, Page 97.

N

"National Committees, 1958 AISE"—January, 1958, Page 93.
"New Combustion Process for Temperature Uniformity in Heat Treating Furnaces, A"—By F. C. T. DANIELS and STEVE STASKO, July, 1958, Page 85.
"Noise—A Problem of Physical and Human Engineering"—By RICHARD D. LEMMERMAN and RICHARD R. AUDETTE, October, 1958, Page 116.

O

"Officers and Directors, 1958 AISE"—January, 1958, Page 90.
"Oil Film Bearings on European Mills, Maintenance of"—By SAMUEL CARSON, April, 1958, Page 90.
"Oils for Processing, Rustproofing"—By EUGENE R. SLABY, January, 1958, Page 102.
"Open Hearth Fuel Atomization With a Reaction-Type Jet Burner"—By A. L. HODGE and G. W. HINDS, December, 1958, Page 88.
"Open Hearth Furnace, The Oxidation Mechanism in the"—By A. L. HODGE, November, 1958, Page 97.
"Open Hearth Furnaces, Accelerated Firing Rates in"—By E. T. W. BAILEY, October, 1958, Page 124.
"Open Hearth Furnaces, Carbon Black in Fuel Oil for"—By G. W. TESKEY, JR., October, 1958, Page 71.
"Operating and Mechanical Features of New 46 × 100 In. High-Lift Blooming Mill at Stelco"—By A. C. GRAY and J. G. MITCHELL, August, 1958, Page 123.
"Operation and Maintenance of a 100-ton Double-Cycle, Gaseous Oxygen Plant"—By G. T. WRIGHT, May, 1958, Page 81.
"Operational Features of 45-In. Slab Mill and 80-In. Hot Strip Mill at Fairless Works"—By T. D. CLIFFORD, September, 1958, Page 198.
"Operator's Evaluation of the Versatile Gas Turbine"—By GEORGE H. KRAPF and H. J. GIFFORD, June, 1958, Page 98.
"Ore in the United States, The Direct Reduction of Iron"—By HARRY W. McQUAID, January, 1958, Page 69.
"Oxidation Mechanism in the Open Hearth Furnace, The"—By A. L. HODGE, November, 1958, Page 97.
"Oxygen and the Steel Plant": "Summary of Operating Results"—By J. H. STRASSBURGER; "Benefits of Purchased Oxygen to the Indiana Harbor Works of the Inland Steel Co."—By N. R. KIRKDOFFER; "Economics of Generated vs Purchased Oxygen for Steel Plant Use"—By R. A. LAMBERT; "Operation and Maintenance of a 100-ton Double-Cycle, Gaseous Oxygen Plant"—By G. T. WRIGHT; "Maintenance Experience with Oxygen Plants at Sparrows Point"—By A. STUTZER; "Oxygen Plant Cycles Tailored to Requirements of Iron and Steel Producers"—By CLARENCE J. SCHILLING, May, 1958, Page 69.
"Oxygen for Steel Plant Use, Economics of Generated vs Purchased"—By R. A. LAMBERT, May, 1958, Page 76.
"Oxygen to the Indiana Harbor Works of the Inland Steel Company, Benefits of Purchased"—By N. R. KIRKDOFFER, May, 1958, Page 71.
"Oxygen Plant Cycles Tailored to Requirements of Iron and Steel Producers"—By CLARENCE J. SCHILLING, May, 1958, Page 86.
"Oxygen Plant, Operations and Maintenance of a 100-ton Double-Cycle, Gaseous Oxygen Plant"—By G. T. WRIGHT, May, 1958, Page 81.
"Oxygen Plants at Sparrows Point, Maintenance Experience with"—By A. STUTZER, May, 1958, Page 84.

P

"Painting Remainders for Steel Plants, Ten"—By WALTER T. YARHOUSE, September, 1958, Page 129.
"Physical and Human Engineering, Noise—A Problem of"—By RICHARD D. LEMMERMAN and RICHARD R. AUDETTE, October, 1958, Page 116.
"Pickle-Liquor Treatment, The Dollars and Sense of"—By JAMES S. JOSEPH and E. T. CULVER, March, 1958, Page 112.
"Pictorial Roundup, AISE Spring Conference"—May, 1958, Page 108.
"Pictorial Roundup—AISE Western Meeting"—April, 1958, Page 88.
"Planetary Mill and Its Uses, The"—By T. SENDZIMIR, January, 1958, Page 95.
"Planned Maintenance Techniques for a Hot Strip Mill"—By JAMES R. KENNEDY, October, 1958, Page 139.
"Pollution Reflects Operating Practices, Stream"—By JOHN E. KINNEY, April, 1958, Page 97.
"Pollution, Tackling Water"—By E. G. PAULSON and EVERETT P. PARTRIDGE, November, 1958, Page 123.
"Power Layouts in Steel Mills"—By A. J. MOSSO, February, 1958, Page 111.
"Power Plants, Trends in Steel Mill"—By HOWARD G. KITT and ROBERT W. WORLEY, March, 1958, Page 90.
"Power System, Factors in the Design of a Steel Plant"—By A. J. F. MACQUEEN, October, 1958, Page 92.
"Precipitators, Modifications to the Fontana Open Hearth"—By EARL V. AKERLOW, July, 1958, Page 97.
"President's Message, The"—January, 1958, Page 88.
"Press and Its Controls, A Modern Forging"—By OTTO HOFFMANN and ALEX KRYNYTZKY, June, 1958, Page 81.
"Primary Roll Neck Bearings and their Protection"—By GEORGE SACKERSON, February, 1958, Page 102.
"Processing Lines, Recent Advances in Control Systems for Continuous"—By C. P. BROOKS and J. T. BRADFORD, October, 1958, Page 129.
"Production of Seamless Casing and Tubing"—By MELVIN SUMRALL, March, 1958, Page 138.
"Program, 1958 AISE Annual Convention and Exposition"—August, 1958, Page 101.
"Program—1958 AISE Annual Convention and Iron and Steel Exposition"—September, 1958, Page 176.
"Program—AISE Spring Conference"—March, 1958, Page 103.
"Programming Control of Rolling Mills—I, Card"—By ROBERT W. HOLMAN, June, 1958, Page 113.
"Programming Control of Rolling Mills—II, Card"—By R. G. BEADLE and W. E. MILLER, June, 1958, Page 115.
"Progress in Developing Fire-Resistant Hydraulic Fluids"—By S. P. POLACK, August, 1958, Page 87.
"Progress—Past and Future"—By C. L. HUSTON, JR., August, 1958, Page 69.
"Proper Installation and Maintenance of Electric Control Systems"—By J. W. BAUER, JR., April, 1958, Page 128.
"Protection Against Prolonged Delays on Main Drive Electrical Equipment"—By H. H. ANGEL, April, 1958, Page 77.
"Pueblo Plant, Symposium on C. F. & I's": "Production of Seamless Casing and Tubing"—By MELVIN SUMRALL; "Installation of Stretch Reducing Mill"—By HOWARD L. MITCHELL; "Double Cooling Bed for Rod Mill"—By D. H. DRISCOLL and CLAIR RENBERG, March, 1958, Page 138.
"Pumpability and Heat Stability in Industrial Greases, Importance of"—By WM. A. MAGIE, 2ND, October, 1958, Page 87.

R

"Railroad Car Rebuilds and Repair at Kaiser's Fontana Works"—By A. B. STOKER, August, 1958, Page 132.
"Rebuilding, Recent Innovations in Blast Furnace Maintenance and"—By LOUIS TOROK, September, 1958, Page 173.
"Recent Advances in Control Systems for Continuous Processing Lines"—By C. P. BROOKS and J. T. BRADFORD, October, 1958, Page 129.
"Recent Developments in Slabbing Mills"—By H. J. KALBERKAMP, February, 1958, Page 73.
"Recent Hot Strip Mill Roughing Trains"—By JOHN H. GREINER, September, 1958, Page 151.
"Recent Innovations in Blast Furnace Maintenance and Rebuilding"—By LOUIS TOROK, September, 1958, Page 173.
"Recent Lubrication Experiences in the Sparrows Point Plant"—By THOMAS A. BESSENT, December, 1958, Page 117.
"Rectifiers in the Steel Industry, The Application of Silicon and Germanium Power"—By R. J. MORAN, August, 1958, Page 117.
"Recuperators, Developments in Metallic"—By THOMAS E. DIXON and HEINZ A. KUHNE, January, 1958, Page 127.
"Reducing Mill, Installation of Stretch"—By HOWARD L. MITCHELL, March, 1958, Page 139.
"Relationship Between Scleroscope, Rockwell and Brinell Hardness Readings"—By N. R. ARANT and J. J. MARSALKA, February, 1958, Page 160.
"Republic in the South"—By T. J. ESS, April, 1958, Page R-1.
"Review of European Steel Plant Progress—1957, A"—By R. C. McMICHAEL, August, 1958, Page 73.
"Rod, Bars and Strip, A Combination Mill for Rolling"—By ERNEST E. DAVIS, April, 1958, Page 101.
"Rod Mill, Double Cooling Bed for"—By D. H. DRISCOLL and CLAIR RENBERG, March, 1958, Page 141.
"Rod Mill, Electrical Drive System For a High Speed Combination"—By A. F. KENYON and H. J. OAKES, March, 1958, Page 123.

"Rod Mill, Electrical Equipment for a Modern"—By E. L. ANDERSON, January, 1958, Page 112.
"Roll Hardening Operations, Application of Progressive Induction Heating to Forged"—By JOHN DUGAN, November, 1958, Page 65.
"Rolling Mill Slippers": "Design of Rolling Mill Slippers"—By F. J. GLEVE; "Material of Rolling Mill Slippers"—By R. J. SEVERSON, May, 1958, Page 127.
"Rolling Mills—I, Card Programming Control of"—By ROBERT W. HOLMAN, June, 1958, Page 113.
"Rolling Mills—II, Card Programming Control of"—By R. G. BEADLE and W. E. MILLER, June, 1958, Page 115.
"Rolling, Turn-Up and Turn-Down in Hot"—By G. E. KENNEDY and F. SLAMAR, March, 1958, Page 71.
"Rolls, Automatic Contour Turning of Large Mill"—By WILLIAM HYAMS, March, 1958, Page 82.
"Roughing Trains, Recent Hot Strip Mill"—By JOHN H. GREINER, September, 1958, Page 151.
"Rustproofing Oils for Processing"—By EUGENE R. SLABY, January, 1958, Page 102.

S

"Safeguarding Steel Production"—By R. M. L. RUSSELL, July, 1958, Page 112.
"Seamless Tube Making by the Calmes Process"—By DR. ALBERT CALMES and CLYDE A. ROBERTS, February, 1958, Page 124.
"Selection of Electrical Equipment for Temper and Skin Pass Mills"—By J. E. PEEBLES, J. J. REMLEY and R. B. EGGLESTON, September, 1958, Page 115.
"Shaft Alinement and What It Means"—By WALTER T. SAVELAND, JR., September, 1958, Page 103.
"Silicon and Germanium Power Rectifiers in the Steel Industry, The Application of"—By R. J. MORAN, August, 1958, Page 117.
"Skin Pass Mills, Selection of Electrical Equipment for Temper and"—By J. E. PEEBLES, J. J. REMLEY and R. B. EGGLESTON, September, 1958, Page 115.
"Slab Mill and 80-In. Hot Strip Mill at Fairless Works, Operational Features of 45-In."—By T. D. CLIFFORD, September, 1958, Page 198.
"Slabbing Mills, Recent Developments in"—By H. J. KALBERKAMP, February, 1958, Page 73.
"Slippers, Rolling Mill": "Design of Rolling Mill Slippers"—By F. J. GLEVE; "Material of Rolling Mill Slippers"—By R. J. SEVERSON, May, 1958, Page 127.
"Soaking Pits with a High Velocity Combustion System"—By DAVID C. HANEY, November, 1958, Page 82.
"Some Practical Solutions to Hot Mill Problems"—By R. A. SMITH and A. D. PATTON, July, 1958, Page 92.
"Sparrows Point, Maintenance Experience with Oxygen Plants at"—By A. STUTZER, May, 1958, Page 84.
"Sparrows Point Plant, Recent Lubrication Experiences in the"—By THOMAS A. BESSENT, December, 1958, Page 117.
"Spray Lubrication, Development and Application of"—By E. J. GESDORF, May, 1958, Page 115.
"Spring Conference, Program—AISE"—March, 1958, Page 103.
"Standard No. 8, Crane and Mill Auxiliary Drive Motor Cable Size Wiring Standards, AISE"—December, 1958, Page 132.
"Standardization of Steel Mill Crane Control Systems"—By K. S. KUKA, December, 1958, Page 61.
"Standardized Component Parts for Heavy Duty Mill Type Cranes"—By MYRON R. BOWERMAN and ELVIN R. MADISON, July, 1958, Page 104.
"Steel Industry of Mexico—Its Present and Immediate Future, The"—By ING. PASCUAL GUTIERREZ ROLDAN, January, 1958, Page 80.
"Steel Plant, Oxygen and the": "Summary of Operating Results"—By J. H. STRASSBURGER; "Benefits of Purchased Oxygen to the Indiana Harbor, Works of the Inland Steel Co."—By N. R. KIRKDOFFER; "Economics of Generated vs Purchased Oxygen for Steel Plant Use"—By R. A. LAMBERT; "Operations and Maintenance of a 100-ton Double-Cycle, Gaseous Oxygen Plant"—By G. T. WRIGHT; "Maintenance Experience with Oxygen Plants at Sparrows Point"—By A. STUTZER; "Oxygen Plant Cycles Tailored to Requirements of Iron and Steel Producers"—By CLARENCE J. SCHILLING, May, 1958, Page 69.
"Stelco, Operating and Mechanical Features of New 46 × 100 In. High-Lift Blooming Mill at"—By A. C. GRAY and J. G. MITCHELL, August, 1958, Page 123.
"Storage for Peak Demands, Gas"—By ROBERT KYLE, August, 1958, Page 109.
"Stream Pollution Reflects Operating Practices"—By JOHN E. KINNEY, April, 1958, Page 97.
"Strip, A Combination Mill for Rolling Rod, Bars and"—By ERNEST E. DAVIS, April, 1958, Page 101.
"Strip Dimensions on Hot Strip Finishing Mills, Methods of Control of"—By R. A. PHILLIPS, May, 1958, Page 100.
"Strip Mill at Fairless Works, Operational Features of 45-In. Slab Mill and 80-In. Hot"—By T. D. CLIFFORD, September, 1958, Page 198.
"Strip Mill, Planned Maintenance Techniques for a Hot"—By JAMES R. KENNEDY, October, 1958, Page 139.
"Strip Mill Roughing Trains, Recent Hot"—By JOHN H. GREINER, September, 1958, Page 151.
"Strip Mills, Development of Automatic Thickness Controls for"—By I. G. Orellana, March, 1958, Page 144.
"Strip Mills, Maintenance of Backup Roll Bearings in"—By W. M. LEWIS, November, 1958, Page 115.
"Structural Design Problems and Recommended Practice for Ore Bridges and Unloaders"—By WILLIAM B. McLEAN, August, 1958, Page 78.
"Structural Steel Handling with Mobile Equipment"—By P. F. WALKER, November, 1958, Page 110.
"Summary of Operating Results"—By J. H. STRASSBURGER, May, 1958, Page 69.
"Symposium on C. F. & I's Pueblo Plant": "Production of Seamless Casing and Tubing"—By MELVIN SUMRALL; "Installation of Stretch Reducing Mill"—By HOWARD L. MITCHELL; "Double Cooling Bed for Rod Mill"—By D. H. DRISCOLL and CLAIR RENBERG, March, 1958, Page 138.

T

"Tackling Water Pollution"—By E. G. PAULSON and EVERETT P. PARTRIDGE, November, 1958, Page 123.
"Tandem Cold Mills, An Automatic Gage Control System for"—By N. S. WALKER, J. W. COOK and J. W. WALLACE, July, 1958, Page 124.
"Techniques in Rebuilding a Blast Furnace"—By C. F. BESSENT, February, 1958, Page 82.
"Temper and Skin Pass Mills, Selection of Electrical Equipment for"—By J. E. PEEBLES, J. J. REMLEY and R. B. EGGLESTON, September, 1958, Page 115.
"Ten Painting Reminders for Steel Plants"—By WALTER T. YARHOUSE, September, 1958, Page 129.
"Thickness Controls for Strip Mills, Developments of Automatic"—By I. G. ORELLANA, March, 1958, Page 144.
"Tomorrow's Engineer"—By N. C. MICHELS, June, 1958, Page 104.
"Trends in Ingot Buggy Design"—By H. G. FROSTICK, October, 1958, Page 78.
"Trends in Steel Mill Power Plants"—By HOWARD G. KITT and ROBERT W. WORLEY, March, 1958, Page 90.
"Trolleys Allow Larger Open Hearth Heats, Light Weight Ladle Crane"—By F. C. SCHOEN, September, 1958, Page 107.
"Tube Making by the Calmes Process, Seamless"—By DR. ALBERT CALMES and CLYDE A. ROBERTS, February, 1958, Page 124.
"Tubing, Production of Seamless Casing and"—By MELVIN SUMRALL, March, 1958, Page 138.
"Turbine, An Operator's Evaluation of the Versatile Gas"—By GEORGE H. KRAPF and H. J. GIFFORD, June, 1958, Page 98.
"Turbines for Blast Furnace Blowing, Gas"—By G. H. KRAPF and J. O. STEPHENS, September, 1958, Page 142.
"Turning of Large Mill Rolls, Automatic Contour"—By WILLIAM HYAMS, March, 1958, Page 82.
"Turn-Up and Turn-Down in Hot Rolling"—By G. E. KENNEDY and F. SLAMAR, March, 1958, Page 71.

U

"Unloaders, Structural Design Problems and Recommended Practice for Ore Bridges and"—By WILLIAM B. McLEAN, August, 1958, Page 78.

V

"Ventilation of Large Industrial Buildings Under Heat Load"—By F. E. TUCKER, June, 1958, Page 107.

W

"Weirton Steel Co."—By T. J. ESS, November, 1958, Page W-1.
"Welding, Magnetic-Flux Gas Shielded Arc"—By J. E. DATO, September, 1958, Page 160.
"When Do You Change Wire Rope Cables?"—By J. E. GRIMWOOD, June, 1958, Page 94.
"Wire Rope Cables?, When Do You Change"—By J. E. GRIMWOOD, June, 1958, Page 94.
"Wiring Standards, AISE Standard No. 8, Crane and Mill Auxiliary Drive Motor Cable Size"—December, 1958, Page 132.

"500-Ton Hot Metal Ladle Crane"—By CHARLES F. SIMMERS, December, 1958, Page 124.
" 1957, Coke and By-Products in"—By I. E. Madsen, December, 1958, Page 73.
"1957, Developments in the Iron and Steel Industry During"—By I. E. MADSEN, January, 1958, Page 139.

ROY T. HURLEY

Portrait by Bachrach

"More than 11,000 of our 19,000 employees are now buying U.S. Savings Bonds Regularly"

"We are delighted to see the steady increase in the number of our people who are buying U.S. Savings Bonds through the payroll plan. More than 59% of our employees are now enrolled.

"To enjoy the benefits of peace and freedom, we must provide for our own personal financial security and, at the same time, create the power for peace through support of an adequate defense program. Systematic savings through the Savings Bond program will keep us ahead of any potential aggressor and help insure the soundness of an economic system which encourages and permits each of us to look forward to a bright, secure future."

ROY T. HURLEY, ***Chairman and President, Curtiss-Wright Corporation***

Today there are more Payroll savers than ever before in peacetime. If employee participation in *your* Payroll Savings Plan is less than 50% . . . or if *your* employees now do not have the opportunity to build for their future through the systematic purchase of U.S. Savings Bonds, give your State Director an opportunity to help. Look him up in your phone book. Or write: Savings Bonds Division, U.S. Treasury Dept., Washington, D.C.

IRON AND STEEL ENGINEER

THE U. S. GOVERNMENT DOES NOT PAY FOR THIS ADVERTISEMENT. THE TREASURY DEPARTMENT THANKS, FOR THEIR PATRIOTISM, THE ADVERTISING COUNCIL AND THE DONOR ABOVE

INDEX TO ADVERTISERS

DECEMBER, 1958

A

Adalet Manufacturing Co., The ... 202
Adams Co., Inc., R. P. ... 183
Aetna-Standard Engineering Co. ... 1
Air Products, Inc. ... 56
Alliance Machine Co. ... 150, 151
Allis-Chalmers Manufacturing Co. ... 167, 168, 169
Aluminum Co. of America ... 19, 181
Appleton Electric Co. ... 45
Atlas Car & Manufacturing Co. ... 196
Automatic Transportation Co. ... Cover 1

B

Bailey Meter Co. ... 186
Bearings, Inc. ... 187
Berry Bearing Co. ... 175
Bethlehem Steel Co. ... 200
Blaw-Knox Co. ... 170
Bliss Co., E. W. ... 7
Bloom Engineering Co., Inc. ... 203
Bristol Co., The ... 197
Browning and Co., Inc., Victor R. ... 172
Bussmann Manufacturing Div., McGraw-Edison Co. ... 146, 147

C

Chemical Construction Corp. ... 44
Cleveland Crane and Engineering Co., The ... 10
Cleveland Tramrail Div., Cleveland Crane & Engineering Co., The ... 154
Cleveland Worm and Gear Co., The ... Cover 3
Cone-Drive Gears Div., Michigan Tool Co. ... 12
Crouse-Hinds Co. ... 23
Cunningham Co., M. E. ... 44
Cutler-Hammer, Inc. ... Cover 2

D

Demag Aktiengesellschaft ... 24
Dowell ... 193
Dravo Corp. ... 4, 5
Drever Co. ... 35
Duraloy Co., The ... 164

E

Electric Controller & Mfg. Co., Square D Co. ... 38
Electric Furnace Co., The ... 173
Elliott Co. ... 46

F

Feller Engineering Co. ... 188
Femco, Inc. ... 199

G

General Electric Co. ... 20, 21, 140, 141, 142
General Refractories Co. ... 30
General Steel Castings Corp., National Roll & Foundry Div. ... 149
Great Lakes Carbon Corp. ... 166
Green Fuel Economizer Co., Inc., The ... 27
Guyan Machinery Co. ... 204

H

Harnischfeger Corp. ... 42, 43
Hill Acme Co., Cleveland Knife Div. ... 183
Hyde Park Foundry and Machine Co. ... 202

J

Johns-Manville Corp. ... 14, 152, 153, 192

K

Kaiser Engineers ... 52
Koppers Co., Inc. ... 36, 37, 58, 59, 184

L

Larco, Inc. ... 185
Lectromelt Furnace Div., McGraw-Edison Co. ... 60
Link-Belt Co. ... 18, 49, 198
Loewy-Hydropress Div., Baldwin-Lima-Hamilton Corp. ... 161

M

Mackintosh-Hemphill Div., E. W. Bliss Co. ... 29
Manning, Maxwell and Moore, Inc. ... 53
Marland One-Way Clutch Co. ... 204
Matthews & Co., Jas. H. ... 201
Mesta Machine Co. ... 178
Morgan Construction Co. ... 39

N

National Carbon Co., Union Carbide Corp. ... 16
National Electric Coil Co. ... 216
National Roll & Foundry Div., General Steel Castings Corp. ... 149

O

Ohio Steel Foundry Co., The ... 162

P

Pangborn Corp. ... 191
Pannier Corp., The ... 185
Pennsylvania Transformer Div., McGraw-Edison Co. ... 176
Pittsburgh Engineering & Machine Co. ... 158
Poole Foundry and Machine Co. ... 189
Post-Glover Electric Co. ... 144

R

Radio Corp. of America ... 13
Reliance Electric & Engineering Co. ... 174
Republic Flow Meters Co. ... 190
Roberts & Schaefer Co. ... 177
Rust Furnace Co., The ... 139

S

Spraying Systems Co. ... 171
Square D Co. ... 9
Stamco, Inc. ... 185
Surface Combustion Corp. ... 50, 51
Sutton Engineering Co. ... 165
Swindell-Dressler Corp. ... 54, 55

T

Taylor Chain Co., S. G. ... 201
Taylor Instrument Cos. ... 48
Taylor Sons Co., Chas., The ... 22
Texas Co., The ... Cover 4
Timken Roller Bearing Co., The ... 47
Torrington Co., The ... 41
Trabon Engineering Corp. ... 194

U

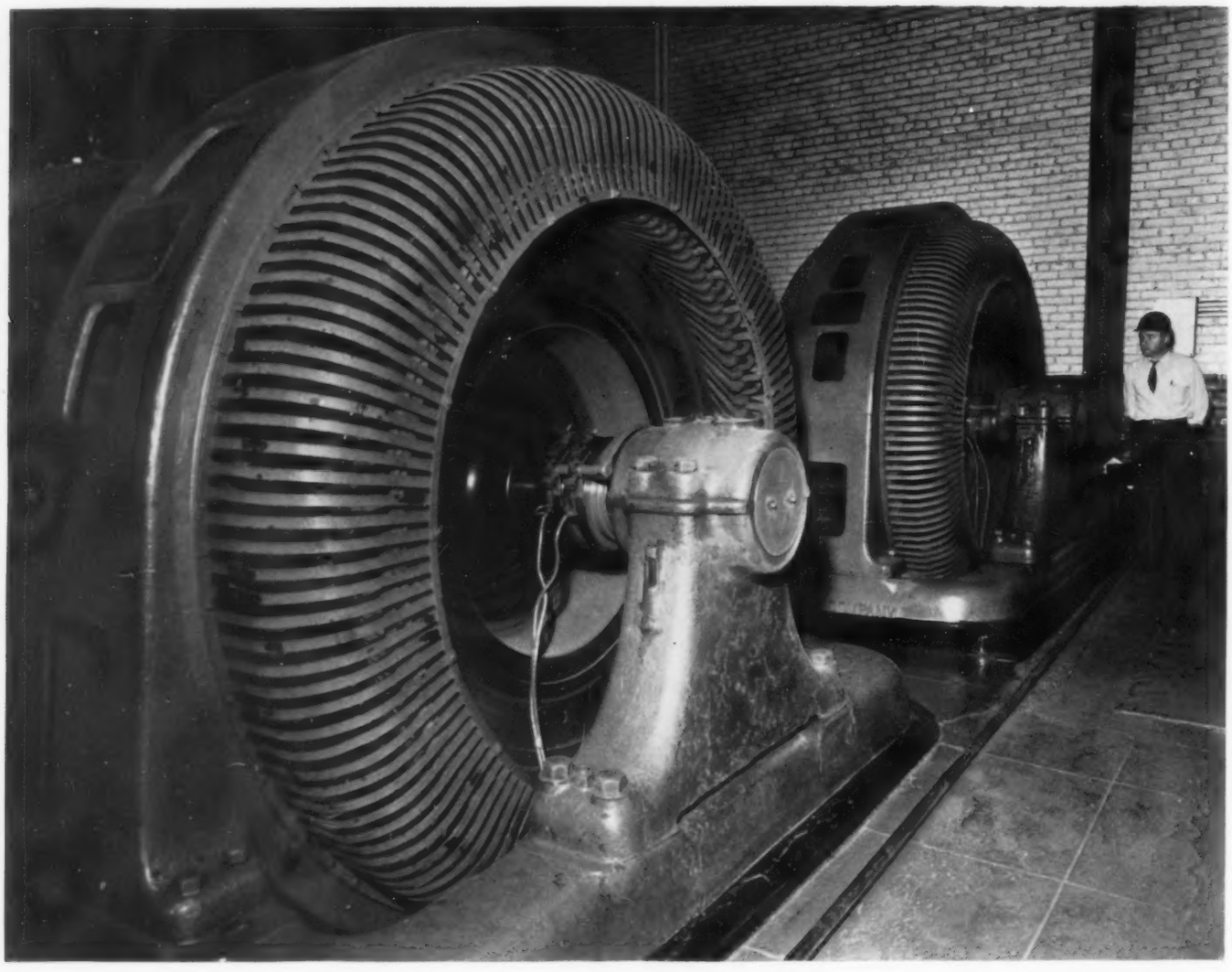
Union Carbide Corp., National Carbon Co. ... 16
United Engineering and Foundry Co. ... 17
United Engineers & Constructors Inc. ... 6

W

Wagner Electric Corp. ... 40
Waldron Corp., John ... 34
Wall Colmonoy Corp. ... 171
Waterbury Farrel Foundry and Machine Co. ... 182
Wean Engineering Co., Inc. ... 2
Western Precipitation Corp. ... 8
Whiting Corp. ... 33
Wilson Engineering Co., Inc., Lee ... 15

Y

Youngstown Alloy Casting Corp. ... 157
Youngstown Welding & Engineering Co., The ... 57



NATIONAL serves Weirton Steel Company with replacement windings for large motors and generators

These two 2100 HP, 6600 volt synchronous motors drive 1500 KW, 250 volt generators in the Blooming Mill Substation at the Weirton Steel Company, a division of National Steel Corporation. Both were rewound in 1941 with National coils—windings which have now passed 17 years of continuous service. This job is typical of many which National has done over the years for Weirton and other leading steel producers.

National has the engineering "know-how" and experience and the production manpower and facilities to handle rewinding of your biggest rotating electrical machines. National quality is proved by the performance of National windings . . . like these at Weirton which are still going strong after 17 years of service.

For specific recommendations on how National's engineering and manufacturing ability can best be utilized in your electrical maintenance operations, just call your nearby National field engineer or drop us a line.

NATIONAL ELECTRIC COIL COMPANY

COLUMBUS 16, OHIO, U. S. A. TRADE MARK

ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION—
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

Clevelands power huge USS heat treat furnace

Handling plates as big as 45 ft. long, 13 ft. wide and 2 in. thick, the approach and delivery tables on this new Drever heat treat furnace require dependable power transmission. That's why Cleveland Worm Gear speed reducers were selected for this job in U. S. Steel's 160-inch plate mill.

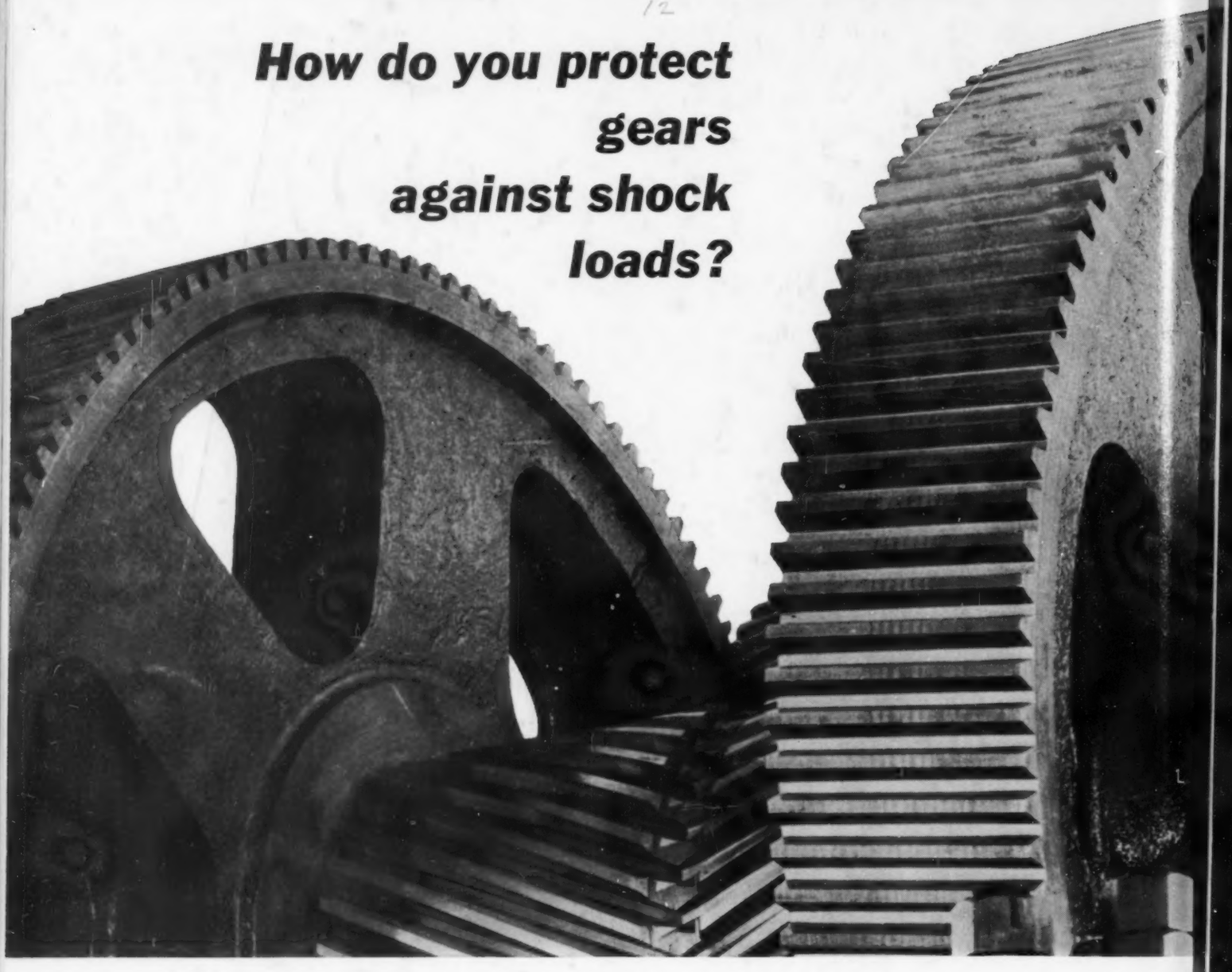
Behind that dependability stands Cleveland's 46 years of design engineering coupled with workmanship of the highest quality.

In steel mills, mines, fabricators . . . anywhere rugged, compact and dependable speed reducers are needed, you'll find Clevelands handling the toughest assignments. To see how Clevelands can handle your most demanding power transmission jobs, ask for Bulletin 145. Write The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

CLEVELAND
Worm Gear
Speed Reducers

Affiliate: The Farval Corporation, Centralized Systems of Lubrication.
In Canada: Peacock Brothers Limited.

How do you protect gears against shock loads?



The great pressures suddenly generated under shock loads can cause serious damage to costly gears unless adequate measures have been taken to prevent it. This is why the choice of the proper lubricant is so important —and why so many steel mills use Texaco Meropa.

Special polar additives in Texaco Meropa Lubricant adhere to metal surfaces with an extremely powerful bond. Even under tremendous shock pressures, a protective film of Meropa remains between gear teeth, effectively guarding the metal against scoring, spalling, ridging or scuffing.

In addition to its ability to withstand extreme pressures, Texaco Meropa can perform its job even under severe heat and moisture conditions. It's non-corrosive, and stable in use, storage or centrifuging. These are some of the reasons why Texaco Meropa keeps gears running longer . . . and maintenance costs low.

Ask your Texaco Lubrication Engineer for the full story on Meropa, and the rest of Texaco's full line of lubricants. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States. Or write:

The Texas Company, 135 East 42nd Street, New York 17, New York.

TUNE IN... Metropolitan Opera Radio Broadcasts Every Saturday Afternoon

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)